5D10
Waveform Digitizer

OPERATORS MANUAL

Tektronix®
COMMITTED TO EXCELLENCE

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5D10
WAVEFORM DIGITIZER
With Options

OPERATORS MANUAL

PLEASE CHECK FOR CHANGE INFORMATION AT THE REAR OF THIS MANUAL.

Tektronix, Inc.
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Service Personnel: Refer to the 5D10 Service Manual (Volume 1 and 2) for information on Installation, Theory of Operation, Maintenance, Calibration, Parts Lists, and Diagrams.

RELATED DOCUMENTATION

The tabbed "ACCESSORIES" page at the rear of the Service Manual (Volume 1) lists the Tektronix part numbers for all Standard Accessories provided with this product. Also, Section 1, General Information, contains a brief basic-content description for the following publications:

MANUALS (Standard Accessories)

5D10 Operators

5D10 Service
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OPERATORS SAFETY SUMMARY

The general safety information in this part of the summary is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

TERMS

IN THIS MANUAL

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

AS MARKED ON EQUIPMENT

CAUTION indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

DANGER indicates a personal injury hazard immediately accessible as one reads the marking.

SYMBOLS

IN THIS MANUAL

Static-Sensitive Devices.

This symbol indicates where applicable cautionary or other information is to be found.

AS MARKED ON EQUIPMENT

DANGER—High voltage.

Protective ground (earth) terminal.

ATTENTION—refer to manual.

WARNINGS

POWER SOURCE

This product is intended to operate in a mainframe connected to a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the mainframe power cord is essential for safe operation.

GROUNDING THE PRODUCT

This product is grounded through the grounding connector of the mainframe power cord. To avoid electrical shock, plug the mainframe power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the mainframe power cord is essential for safe operation.

DANGER ARISING FROM LOSS OF GROUND

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating), can render an electrical shock.

DO NOT OPERATE IN EXPLOSIVE ATMOSPHERES

To avoid explosion, do not operate this product in an atmosphere of explosive gasses.

DO NOT OPERATE PLUG-IN UNIT WITHOUT COVERS

To avoid personal injury, do not operate this product without covers or panels installed. Do not apply power to the plug-in via a plug-in extender.

INTRODUCTION

DESCRIPTION

The 5D10 Waveform Digitizer is designed to enhance the capabilities of 5000-series oscilloscope mainframes. Waveform storage, crt readout, two cursors for point-to-point measurements, pretrigger viewing, user adjustable viewtime, X-Y display, and analog plot output are just a few of the features this double-wide plug-in unit provides.

Waveform storage using digital memory eliminates the need for a storage crt and allows viewing information which occurred prior to a triggering event. Acquisition may be halted by a triggering event and automatically restarted at the end of the user-adjustable viewtime.

A complete numerical display of cursor measurement values, and time base and amplitude settings is generated by the 5D10 (a readout-equipped mainframe is not required).

Cursors (movable markers on the displayed waveforms) define exactly what portion of the signal you wish to measure. Use a single cursor, for numerical readout of time and amplitude of any point on the digitized waveform, or use two cursors to get delta (difference) time and amplitude values with accuracies to 1%.

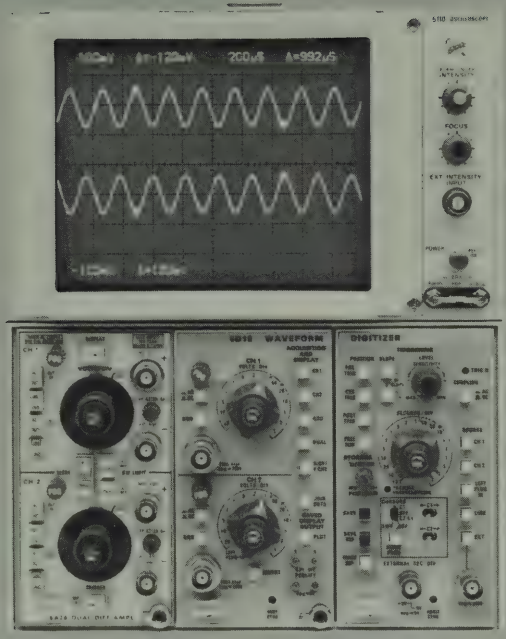
The front panel XY plot output properly connected to an XY recorder provides a hard copy of all information displayed on the crt, including the graticule, cursor measurement values and scale factor settings (time and amplitude).

The 5D10 is capable of displaying and storing three channels simultaneously when used with a dual channel vertical amplifier such as the 5A18N. The Left Plug-In mode also allows the use of other high performance amplifiers to enhance the capabilities of the 5D10. The 5A26 and the 5A22N differential amplifiers offer high sensitivity and differential input.

The fault detection circuitry designed into the 5D10 reduces the uncertainty of servicing this microprocessor oriented plug-in unit. Stimulus stored in ROM exercises the digital circuitry for signature analysis. This method of locating faults in complex digital circuitry affords component level repair with a minimum down time. The self test routine, which is run each time power is applied, assures the operator that the 5D10 is functioning correctly.

SECTION ONE
GENERAL INFORMATION

1



This section contains a basic content description of both the Operators and Service manuals, information on instrument installation, power requirements, packaging for shipment, and specifications. The specification portion consists of three tables; Electrical, Environmental, and Physical Characteristics.

A Standard Accessories list and full-page dimensional drawing of the 5D10 is contained in this section.

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GENERAL INFORMATION

OPERATORS MANUAL

The Operators Manual is divided into the following four sections:

Section 1—General Information contains content descriptions of the Operators and Service manuals, instrument description, mainframe and plug-in compatibility, packaging instructions and instrument specifications.

Section 2—Operating Instructions contains description of all front-panel controls, connectors and indicators and the crt readout fields generated by the 5D10.

A two part operators checkout procedure provides a basic operating procedure for the first-time user followed by a systematic demonstration of all front-panel controls.

Section 3—Applications explains in detail the procedure for making general oscilloscope measurements using the cursor function followed by some specific uses such as making color plots, measuring the settling time of a stepper motor shaft and viewing the events prior to a power supply failure.

Section 4—Instrument Options contains a description of available options, however, there are no options available at this printing.

SERVICE MANUAL

WARNING

THE SERVICE MANUAL CONTAINS INSTRUCTIONS FOR USE BY QUALIFIED SERVICE PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING UNLESS YOU ARE QUALIFIED TO DO SO.

The Service Manual is divided into 2 volumes. Volume 1 contains the following:

Section 1—General Information contains content descriptions of the Operators and Service manuals, mainframe and plug-in compatibility, packaging instructions and instrument specifications.

Section 2—Operating Instructions contains descriptions of all front-panel controls, connectors and indicators and the crt readout fields generated by the 5D10.

A two part operators checkout procedure provides a basic operating procedure for the first-time user followed by a systematic demonstration of all front-panel controls.

Section 3—Theory of Operation contains basic and general circuit analysis that will be useful for servicing the instrument.

Section 4—Maintenance describes routine and corrective maintenance procedures with detailed instructions for replacing assemblies, subassemblies, and individual components.

Section 5—Calibration contains procedures to check the operational performance and electrical characteristics of the instrument. Procedures also include methods for adjustment of the instrument to meet specifications.

Section 6—Instrument Options contains a description of available options, however, there are no options available at this printing.

Section 7—Replaceable Electrical Parts contains information necessary to order replaceable parts and assemblies related to the electrical functions of the instrument.

Section 8—Diagrams and Circuit Board Illustrations includes detailed circuit schematics, locations of assembled boards within the instrument, voltage and waveform information and circuit board component locators.

Section 9—Replaceable Mechanical Parts includes information necessary to order replaceable mechanical parts and shows exploded drawings which identify assemblies.

Volume 2 of the Service Manual contains the diagnostics necessary for troubleshooting the digital circuitry of the 5D10.

INSTALLATION

INITIAL INSPECTION

This instrument was inspected both mechanically and electrically before shipment. It should be free of mars or scratches and should meet or exceed all electrical specifications. To confirm this, inspect the instrument for physical damage incurred in transit and check the basic instrument functions by following the Detailed Checkout Procedure in Section 2, Operating Instructions. Qualified service personnel can verify Performance Requirements by referring to the Calibration section of the service manual. If there is damage or deficiency, contact your local Tektronix Field Office or representative.

OPERATING TEMPERATURE

The 5D10 can be operated where the ambient air temperature is between 0° and +45° C and can be stored in ambient temperatures from -55° to +75° C. After

storage at temperatures outside the operating limits, allow the chassis temperature to reach operating limits before applying power.

MAINFRAME COMPATIBILITY

The 5D10 operates in the right vertical and horizontal compartments of any 5000-series mainframe, however some mainframes may require modification. Refer to Table 1-1 for 5100-series mainframes that require modification to the Interface board before the Left Plug-in mode may be used for channel 2 signal acquisition.

WARNING

Only qualified service personnel are authorized to make modifications.

TABLE 1-1
Mainframe Compatibility

Mainframe	Serial No.	Modification No.
5110	below B126109	M45180
5111	below B134580	
5112	All	
5113	below B116870	
5115	below B094140	

We recommend that all mainframes requiring modification number M45180 also incorporate modification number M44151 to prevent changes in display vertical position and gain when the left plug-in is installed or removed. Modifications are described in the 5D10 Service Manual, Volume 1, Maintenance, for use by qualified service personnel only.

If the 5D10 is used in the 5115 storage oscilloscope, the Enhance control must be rotated fully counterclockwise.

When the 5D10 is installed in the 5223 Digitizing Oscilloscope, the mainframe is used only for real-time displays. The 5223 digitizing functions are inoperative.

If the 5D10 is used in the 5111, 5111A, 5113, 5115, or the 5441 Storage Oscilloscope, the mainframe should be operated only in the non-storage mode.

We do not recommend use of the LEFT PLUG-IN function when the 5D10 is installed in the 5223, 5440, 5441, or the 5444 Oscilloscope Mainframes.

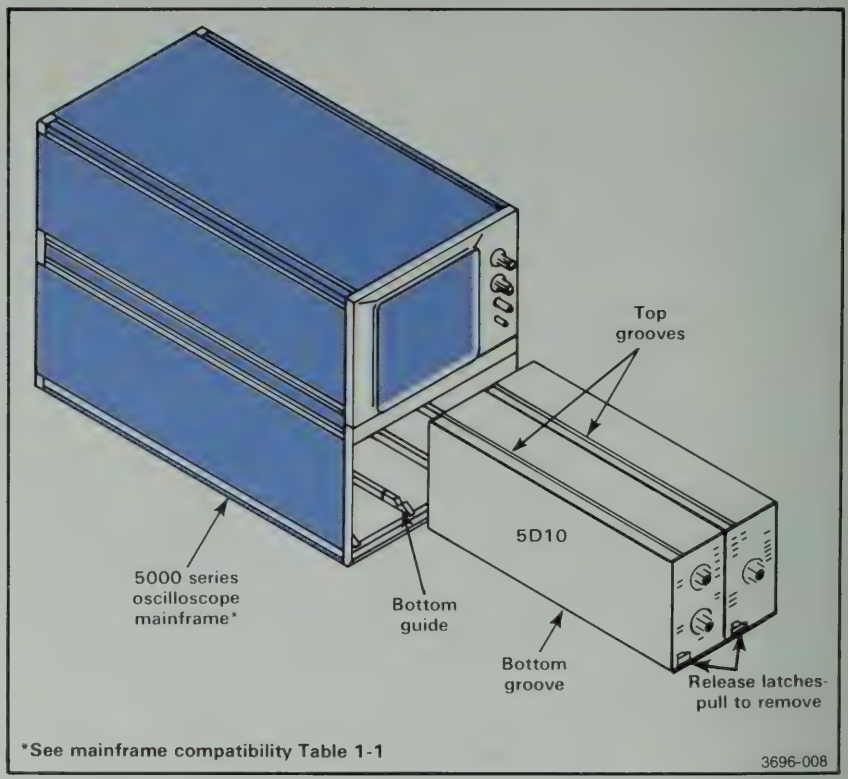

Figure 1-1. Installing the 5D10 in the mainframe.

INSTALLING THE 5D10 IN THE MAINFRAME

The 5D10 is designed to operate in the right vertical and horizontal plug-in compartments.

NOTE

Switch off the mainframe power before installing or removing the 5D10.

To install the 5D10 in the mainframe, align the grooves in the top and bottom of the instrument with the guides at the top and bottom of the plug-in compartment. Then push the 5D10 in until its front panel is flush with the front panel of the mainframe. See Figure 1-1.

NOTE

Make sure that both halves of the 5D10 are firmly seated against the mainframe front panel.

To remove the unit, pull both release latches simultaneously to disengage the unit from the mainframe, then pull it from the plug-in compartments leaving the mainframe on the bench.

PLUG-IN COMPATIBILITY

Any 5000-series amplifier plug-in may be used in the left vertical compartment of the oscilloscope mainframe as a single-trace signal source for 5D10 channel 2 however, we recommend the incorporation of a noise reduction modification to some differential amplifier units. The modification number and affected plug-in units are listed in Table 1-2. For dual-trace acquisition, compatibility considerations listed in Table 1-3 must be observed.

The 5CT1N Curve Tracer is usable with the 5D10 (proper acquisition speed must be selected for proper XY display). However, cursor operation is somewhat difficult, especially if SAVE REF is selected.

TABLE 1-2
Recommended Modification to Differential Amplifier Plug-ins

Plug-in	Serial No.	Modification No.
5A13N	below B051983	M44783
5A20N	all	M44686
5A21N	below B084949	M44686

TABLE 1-3
Plug-In Compatibility

Plug-In	Operating Conditions	Symptom	Cause
5A18N (SN below B128131) 5A26 (SN below B051662)	Dual Trace; 5D10 Sec/Div = 1 ms or faster.	Waveforms distorted.	Plug-in channel switch settling time too slow. 5A18N and 5A26 may be updated with kit, Tektronix Part 040-0963-01 (5A18N) or kit 040-0964-00 (5A26).
5B12N	Dual Sweep; 5D10 Sec/Div = 1 ms or faster.	Waveforms distorted.	Plug-in channel switch settling time too slow.

TABLE 1-3 (CONT)
Plug-In Compatibility

Plug-In	Operating Conditions	Symptom	Cause
5A14N	Any two channels on; 5D10 Sec/Div = 1 ms or faster.	Waveforms distorted.	Plug-in channel switch settling time too slow.
	Three or four channels on.	Display smeared or poor quality.	5D10 not designed to accommodate three- or four-channel Left Vertical acquisition.
	Channel 1 or 2 on; and Channel 3 or 4 on.	Display smeared or poor quality	Dual trace operation requires Channel 1 and 2, or Channel 3 and 4.

PACKAGING FOR SHIPMENT

If this instrument is to be shipped for long distances by commercial transportation, we recommend that the instrument be packaged in the original manner. The carton and packaging material in which your instrument was shipped should be saved and used for this purpose.

NOTE

Package and ship Plug-Ins and Mainframes separately.

Also, if this instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag to the instrument showing the following: Owner of the instrument (with address), the name of a person at your firm who can be contacted, complete instrument type and serial number, and a description of the service required.

If the original packaging is unfit for use or not available, package the instrument as follows:

1. Obtain a corrugated cardboard shipping carton having inside dimensions at least six inches greater than the instrument dimensions; refer to Table 1-4 for carton test strength requirements.

2. Enclose the instrument with polyethylene sheeting or equivalent to protect the finish of the instrument.

TABLE 1-4
Shipping Carton Test Strength

Gross Weight (lb)	Carton Test Strength (lb)
0-10	200
10-30	275
30-120	375
120-140	500

3. Cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument, allowing three inches of packing on each side.

4. Seal the carton with shipping tape or with an industrial stapler.

5. Mark the address of the Tektronix Service Center and your return address on the carton in one or more prominent locations.

SPECIFICATION

The electrical characteristics listed in Table 1-5 apply when the following conditions are met: (1) Calibration of the instrument must have taken place at an ambient temperature between +20° and +30° C, (2) the instrument must be allowed a 20-minute warm-up period, (3) all specifications are valid at an ambient temperature of 0° to +45° C, unless otherwise stated, (4) the instrument must be in an environment that meets the limits described in Table 1-6.

Any applicable conditions not listed above are expressly stated as part of that characteristic. Environmental characteristics are listed in Table 1-6 and Physical characteristics are listed in Table 1-7.

TABLE 1-5
Electrical Characteristics

Characteristic	Performance Requirement
VERTICAL SYSTEM	
Deflection Factor	
Calibrated Steps	1 mV to 20 V per div; 14 steps in a 1-2-5 sequence. Additional position of Channel 2 V/div switch selects signal from Left Plug-In.

TABLE 1-5 (CONT)
Electrical Characteristics

Characteristic	Performance Requirement
VERTICAL SYSTEM (CONT)	
Deflection Factor (Cont)	
Variable Range (Uncal)	Continuously variable between steps.
Accuracy	
Input to Readout Numbers	
1 mV/Div & 2 mV/Div	±2%.
5 mV/Div to 1 V/Div	±1%.
2 V/Div to 20 V/Div	±2%.
Input to Crt Graticule	±2%.
From Left Vertical Plug-In	Add ±1% to above specifications.
Added	Add ±1% to above specifications.
Readout Numbers to CRT	±2%.
Bandwidth	
Single Channel	Suitable for dc to 100 kHz.
Dual Channel	Suitable for dc to 50 kHz.
Input	
R and C	1 MΩ, ±0.5%; 47 pF approximately.
Voltage (Maximum)	250 V (dc + peak ac); 250 V ac p-p at 1 kHz or less.
AC Coupling (-3 dB Point)	10 Hz or less (1 Hz with 10X probe).
Position Range	At least ±5 div.
Common Mode Rejection Ratio (Add, CH 2 Invert)	At least 50:1, dc to 100 kHz.
Channel Isolation	
Input Related	At least 80 dB, dc to 100 kHz.

TABLE 1-5 (CONT)
Electrical Characteristics

Characteristic	Performance Requirement
VERTICAL SYSTEM (CONT)	
Channel Isolation (Cont)	
Display Related	At least 40 dB, dc to 100 kHz (between Ch 1 and Ch 2). At least 34 dB, dc to 100 kHz (between) left plug-in channels acquired by Ch 2).
Phase Shift	
DC to 100 kHz	Less than 1.0 degree phase shift between Ch 1 and Ch 2.
Resolution	
X-Y and Y-T	0.04 div (8-bit digitizer).
HORIZONTAL SYSTEM	
Time Base	
Calibrated Rates	0.1 ms to 50 sec/div, 18 steps in a 1-2-5 sequence.
Uncalibrated	Continuously variable between steps.
Accuracy	±1% (to readout numbers).
External Input	Allows external pulse generator to determine acquisition rate. Sampling occurs on negative-going edge of input pulse.
Voltage	TTL levels.
Frequency (Max)	1 MHz.
Resolution	
X-Y	0.04 div (8-bit digitizer).
Y-T	0.01 div (1024 memory locations shared among all traces acquired).

TABLE 1-5 (CONT)
Electrical Characteristics

Characteristic	Performance Requirement
HORIZONTAL SYSTEM (CONT)	
POSSIBLE UNDERSAMPLING Indicator	Indicator lights when fewer than eight sample pulses occur during interval between successive threshold crossings of triggering signal. Depends on Trigger SOURCE, LEVEL, and SLOPE control settings.
TRIGGERING SYSTEM	
Sources	Channel 1, Channel 2, Left plug-in (via mainframe), Line, External.
Coupling	Dc, ac.
Sensitivity	
+ or − Slope	
External	100 mV, dc to 50 kHz or pulse width greater than 5 μs. 250 mV, 50 kHz to 250 kHz or pulse width greater than 1 μs.
CH 1, CH 2, Left	0.4 div, dc to 50 kHz, or pulse width greater than 5 μs. 1.0 div, 50 kHz to 250 kHz, or pulse width greater than 1 μs.
Bi-Slope Trigger	Amplitude, frequency, and pulse width of + or − specifications apply to absolute value of signal (i.e., rectified).
External Input	
R and C	1 MΩ, ±2%; 47 pF approximately.
Voltage (Max)	250 V (dc + peak ac); 250 V p-p ac at 1 kHz or less.
TRIG'D Indicator	Indicator lights when triggering signal passes through threshold.

TABLE 1-5 (CONT)
Electrical Characteristics

Characteristic	Performance Requirement
RECORDER SYSTEM	
Penlift	
Logic	Isolated (floating) switch, SPST; normally open or normally closed contacts, internal modification to be performed only by qualified service personnel.
Voltage (Max)	5 V, dc or rms.
Current (Max)	50 mA, dc or rms.
Pen-up (blanking) Duration	180 ms, ±20%.
Display Output (X and Y)	
Amplitude	0.2 V/div, within 2%.
Speed	Accomodates recorders with slew rate at least 20 inches/second.

TABLE 1-6
Environmental Characteristics

Characteristic	Performance Requirement
Temperature	
Operating	0°C to +45°C.
Storage	−55°C to +75°C.
Altitude	
Operating	To 15,000 feet (4,500 m). Maximum operating temperature decreases 1°C per 1,000 feet above 5,000 feet.
Storage	To 50,000 feet (15,000 m).
Humidity	
Operating and Storage	5 days, per MIL-STD-810C, method 507-1, Procedure 4, except 90-95% RH.

TABLE 1-6 (CONT)
Environmental Characteristics

Characteristic	Performance Requirement
Vibration	
Operating	Tested to MIL-T-28800B SECT. 4.5.5.3.1 Type 2, Class 5, Style E & F.
Shock	Tested to MIL-T-28800B SECT. 4.5.5.4.1 Type 2, Class 5, Style E & F.
Bench Handling	Tested to MIL-T-28800B SECT. 4.5.5.4.4 Type 2, Class 5, Style E & F.
Transportation	National Safe Transit Assoc., Preshipment Test Procedure.
Vibration and Bounce (packaged product)	NSTA. PROJECT 1 A-B-1.
Drop (packaged product)	NSTA. PROJECT 1 A-B-2.

TABLE 1-7
Physical Characteristics

Characteristic	Information
Weight	2.3 kg (5 lb).
Overall Dimensions	See Figure 1-2, the dimensional drawing.

STANDARD ACCESSORIES

1 ea ..... Operators Manual
1 ea ..... Service Manual (Volume 1)
1 ea ..... 5D10 Diagnostic Troubleshooting Service Manual (Volume 2)

For more detailed information, refer to the tabbed Accessories page at the rear of 5D10 Service Manual, Volume I.

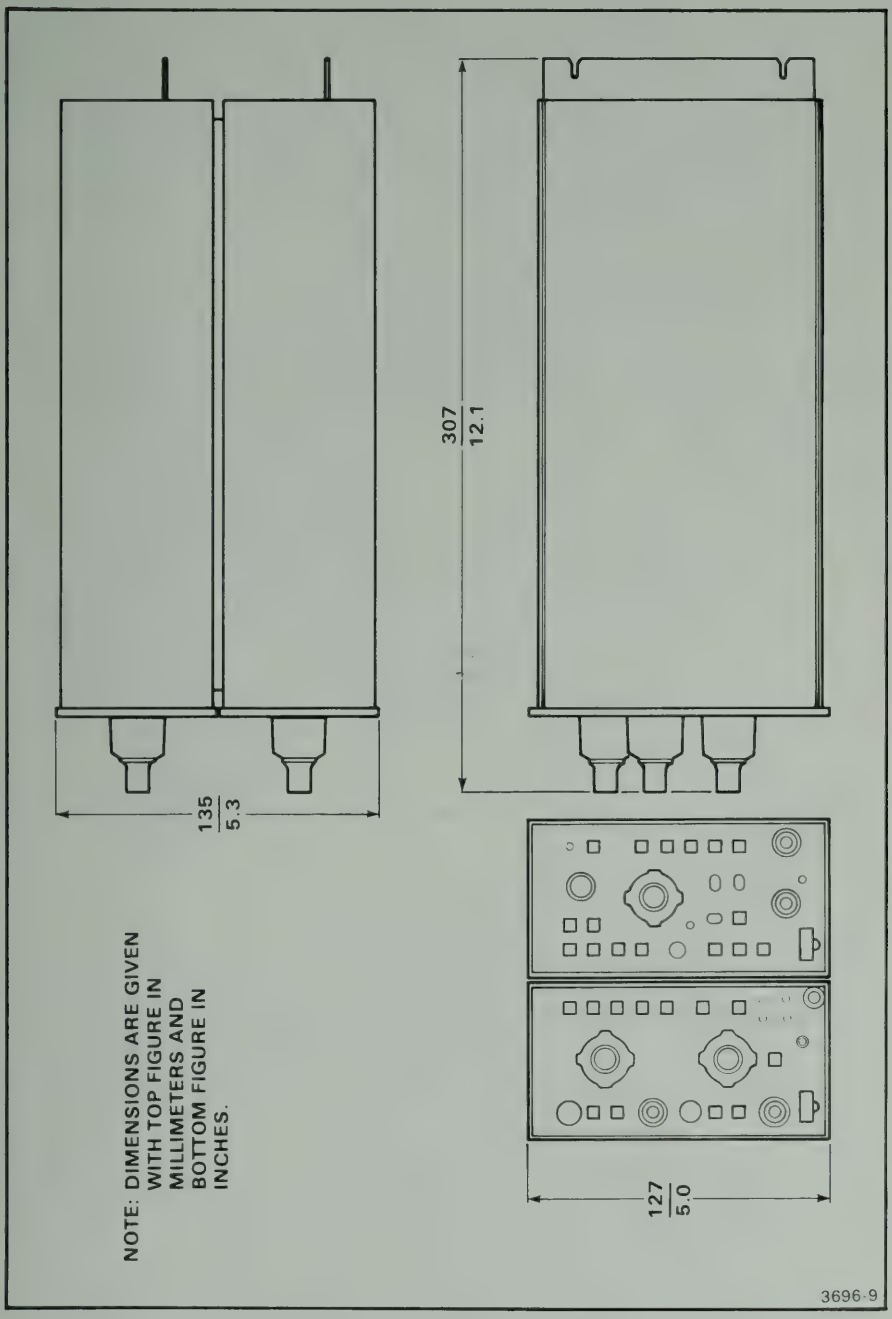

Figure 1-2. Dimensional drawing.

SECTION TWO
OPERATING INSTRUCTIONS

2

This section will familiarize you with the capabilities and operation of the 5D10 Waveform Digitizer. A thorough understanding of this information will remove later uncertainty when operating your equipment.

Familiarization begins with illustrations and descriptions of all front panel controls, connectors and indicators followed by explanations of the crt readout fields generated by the 5D10.

A two-part operators checkout procedure provides a basic operating procedure for the first-time user followed by a systematic demonstration of all front-panel controls.

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OPERATING INSTRUCTIONS

CONTROLS, CONNECTORS, AND INDICATORS

All controls, connectors, and indicators required for the normal operation of the 5D10 Waveform Digitizer unit are located on the front panel; however, recorder pen control and triggering logic can be altered by jumper positioning.

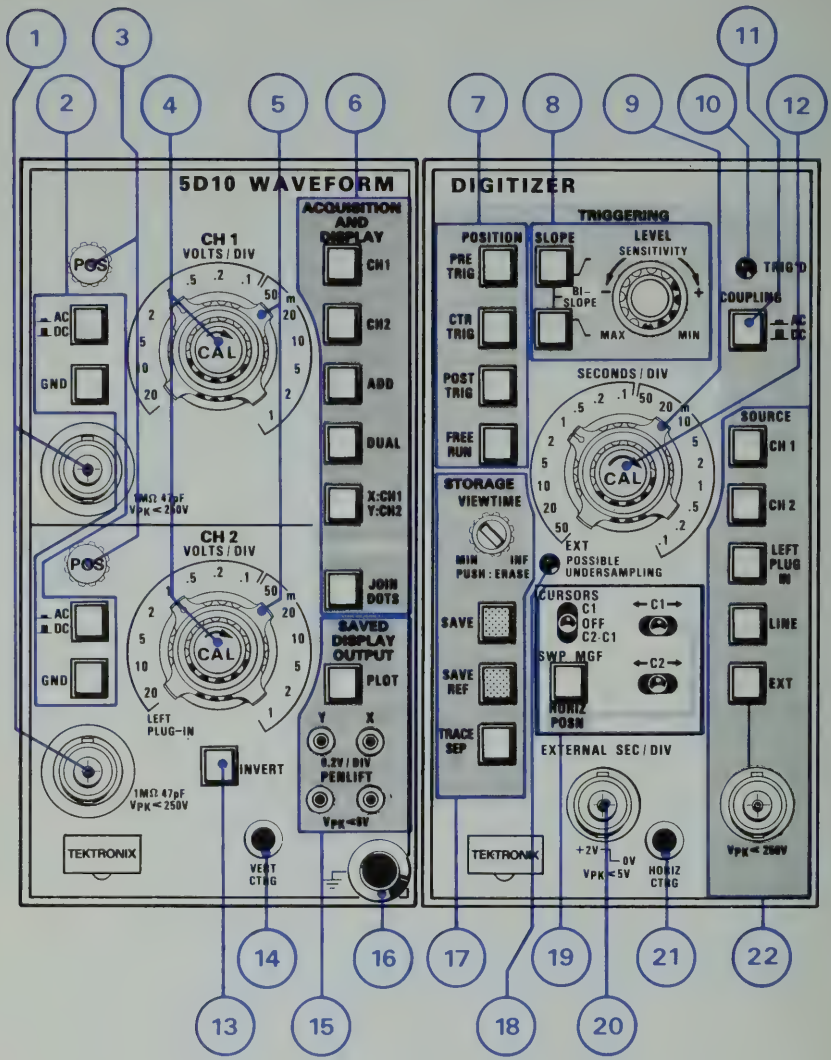
NOTE

Jumper position selectable by qualified service personnel only.

For additional information see Permanent Waveform Records using an X-Y Recorder in Section 3, Applications, and Triggering Logic in the Detailed Operating Instructions later in this section.

Figure 2-1 is provided with numbered controls and connectors to identify the control descriptions that follow.

Foldout for
Front panel controls and connectors
Figure 2-1



3696-7

Figure 2-1. Front panel controls and connectors.

(14) **VERT CTRG**—Screwdriver adjustment of the display vertically. (Compensates for mainframe offsets.)

(15) **SAVED DISPLAY OUTPUT** (SAVE depressed)—

PLOT—Pushing the Plot button causes the screen display to blank, and the display information to be output to the Saved Display Output connectors.

Output connectors—X and Y signal outputs at 0.2 v/div, 10 kΩ, mimic the crt display during Plot activity.

PENLIFT—Connectors provide normally open or normally closed connection for recorder pen control.

Jumper position selectable by qualified service personnel only.

(16) **Ground Connector**—Provides binding post for convenient chassis ground connections.

(17) **STORAGE**—

VIEWTIME—Controls the time the waveform is displayed before being erased and new data acquired[1] and displayed. Viewtime is variable from 1 second to infinity. Infinite viewtime provides single-shot trigger and save capability.

PUSH:ERASE—Push to erase the display before end of timer cycle without disturbing the setting of the viewtime control.

SAVE—Causes acquisition to stop. Memory contents are displayed with no further updating.

SAVE REFerence—Acquisition continues after SAVE REF is pressed. The data displayed prior to pressing SAVE REF is displayed with no further updating. All subsequent data is displayed then updated at the end of the VIEWTIME interval. The data last acquired before SAVE REF was pressed and the new acquired data are displayed simultaneously.

Acquisition continues, but half of memory contents are displayed with no further updating, and half continues being updated.

TRACE SEParation—Causes 'reference' trace to be displayed downward 0.8 division for identification purposes. Active only if SAVE REF button is in.

[1]Acquired, is defined as: Sampled, digitized, and stored in memory.

(1) **Input Connectors**—Bnc connectors (CH 1, CH 2) for applying signals to the amplifiers. A probe coding ring is provided for activating the correct readout when using a 10X probe.

(2) **Input Coupling push-buttons**

AC—DC—Button pushed 'in' selects capacitive coupling of the signal applied to the amplifier. When GND & AC are both 'in' the capacitor precharges to the input signal dc level. The 'out' position provides direct coupling of the input signal.

GND—Grounds the amplifier input while connecting the input signal to ground through a 1 MΩ resistor. If ground is pushed 'in' during an ERASE operation, then the ground reference data in the cursor readout system is updated.

(3) **POSition Controls**—Vertically positions the signal being acquired[1].

(4) **CAL (Variable Volts/Div)**—Provides continuously variable deflection factors between the calibrated settings of the VOLTS/DIV switch and extends the deflection-factor range to ≈ 50 volts/division.

(5) **VOLTS/DIV (CH 1, CH 2)**—Volts per major graticule division. This control selects the calibrated deflection factors from 1 mV to 20 V/DIV, 14 steps in a 1-2-5 sequence. The LEFT PLUG-IN may be selected as the amplifier input for CH 2 only.

(6) **ACQUISITION AND DISPLAY**

CH 1—Selects Channel 1 signal to be acquired[1] and displayed.

CH 2—Selects Channel 2 signal to be acquired[1] and displayed.

ADD—Channel 1 and Channel 2 signals are algebraically added, and the result is acquired[1] and displayed.

DUAL—Channel 1 and Channel 2 signals are separately acquired[1], and displayed as 2 waveforms, in y-t format.

X:CH1, Y:CH2—Channel 1 and Channel 2 signals are separately acquired[1] and displayed as one waveform in X-Y format.

JOIN DOTS—Out position, waveform display consists of dots representing sampled signal values. In position, vectors are displayed between sampled signal values. The dots representing the sampled signal values are not displayed.

[1]Acquired, is defined as: Sampled, digitized, and stored in memory.

(7) **TRIGGERING POSITION**—Selects the trigger point on the saved waveform or defeats triggering (FREE RUN).

After a trigger event is recognized, acquisition continues until enough data to display a full horizontal trace (refer to Triggering Logic in Detailed Operating Instructions) has been acquired[1] then:

in PRE TRIG	7/8 of memory data prior to trigger, 1/8 following is displayed.
in CTR TRIG	1/2 of memory data prior to trigger and 1/2 following is displayed.
in POST TRIG	1/8 of memory data prior to the trigger and 7/8 following is displayed.
in FREE RUN	Acquisition is continuous and stops only when SAVE or SAVE REF is pushed manually.

(8) **TRIGGERING SLOPE, LEVEL, SENSITIVITY**—Selects the amplitude of the window or ± excursion that will cause triggering.

SLOPE—Selects + or − triggering slope signal. If both are pushed in, BI-SLOPE triggering recognizes signal excursion away from zero in either direction (+,−).

LEVEL/SENSITIVITY—With + or − TRIGGERING SLOPE selected, controls the amplitude point at which triggering occurs. With BI-SLOPE triggering selected, controls the sensitivity, or absolute value of signal to cause triggering.

(9) **SECONDS/DIV**—Selects the sampling rate of the digitizing circuits, or in EXT position, selects EXT SEC/DIV input.

(10) **TRIG'D indicator**—Illuminates when the acquired[1] signal is triggered.

(11) **COUPLING**—Selects ac (button in) or dc (button out) coupling of triggering signals.

(12) **CAL**—Selects calibrated or uncalibrated sampling rates. Uncalibrated sampling rates can be continuously reduced to at least the next slowest rate.

(13) **INVERT**—Inverts the Channel 2 signal during acquisition. − symbol in crt readout indicates inverted setting. Triggering signal is not inverted.

[1]Acquired, is defined as: Sampled, digitized, and stored in memory.

(14) **VERT CTRG**—Screwdriver adjustment of the display vertically. (Compensates for mainframe offsets.)

(15) **SAVED DISPLAY OUTPUT** (SAVE depressed)—

PLOT—Pushing the Plot button causes the screen display to blank, and the display information to be output to the Saved Display Output connectors.

Output connectors—X and Y signal outputs at 0.2 v/div, 10 kΩ, mimic the crt display during Plot activity.

PENLIFT—Connectors provide normally open or normally closed connection for recorder pen control.

Jumper position selectable by qualified service personnel only.

(16) **Ground Connector**—Provides binding post for convenient chassis ground connections.

(17) **STORAGE**—

VIEWTIME—Controls the time the waveform is displayed before being erased and new data acquired[1] and displayed. Viewtime is variable from 1 second to infinity. Infinite viewtime provides single-shot trigger and save capability.

PUSH:ERASE—Push to erase the display before end of timer cycle without disturbing the setting of the viewtime control.

SAVE—Causes acquisition to stop. Memory contents are displayed with no further updating.

SAVE REFerence—Acquisition continues after SAVE REF is pressed. The data displayed prior to pressing SAVE REF is displayed with no further updating. All subsequent data is displayed then updated at the end of the VIEWTIME interval. The data last acquired before SAVE REF was pressed and the new acquired data are displayed simultaneously.

Acquisition continues, but half of memory contents are displayed with no further updating, and half continues being updated.

TRACE SEParation—Causes 'reference' trace to be displayed downward 0.8 division for identification purposes. Active only if SAVE REF button is in.

[1]Acquired, is defined as: Sampled, digitized, and stored in memory.

(18) **POSSIBLE UNDERSAMPLING**—The indicator will be on if fewer than 8 samples are taken during each cycle of the triggering signal.

(19) **CURSORS**—(The following 4 functions described are inactive during signal acquisition).

C1/OFF/C2-C1

(1) C1—If selected, provides a single cursor with crt readout of value relative to center screen or ground reference information. Trigger point is also displayed.

(2) C2-C1—If selected, 2 cursors with crt readout of difference values in time and amplitude are displayed.

(3) OFF—No cursors. (SWP MGF is disabled)

SWP MGF (HORIZ POSN)—Magnifies y-t displays by X10, horizontally. Use C1 to select the portion of the waveform to be displayed.

<**C1**>—Moves cursor C1 along trace in direction toggle is pressed (either left or right).

<**C2**>—Moves cursor C2 along trace in direction toggle is pressed (either left or right).

(20) **EXTERNAL SEC/DIV**—Bnc connector for applying TTL clock signal to control sample rate.

(21) **HORIZ CTRG**—Screwdriver adjustment of the display horizontal centering (compensates for mainframe offsets).

(22) **SOURCE**—Selects the source of the triggering signal:

CH 1..... Channel 1 of the 5D10
CH 2..... Channel 2 of the 5D10
LEFT PLUG-IN ... via interface board in the mainframe
LINE .....Power line frequency, from mainframe
EXT ..... External input, through bnc connector

MAINFRAME CRT READOUT FIELDS

The 5D10 provides the readout information to the mainframe circuitry. The scale factor readout fields generated by the 5D10 are shown in Figure 2-2. The cursor readout fields generated by the 5D10 are shown in Figure 2-3. Each value or symbol in the illustrations is identified with a circled number. Following each illustration are definitions, numbered to coincide with those in the illustrations.

NOTE

The particular numbers relating to time and voltage in the following text and illustrations are used for explanation only.

Refer to Operation and Interaction of Save and Save Reference in the Detailed Operating Instructions following the Operators Checkout when SAVE or SAVE REF is mentioned in the following descriptions.

Foldout for
Mainframe crt scale factor readout fields generated by the 5D10
Figure 2-2

If SAVE has been pressed, the SECONDS/DIV setting at the time SAVE was pressed is displayed.

If SAVE REF has been pressed (SAVE out), the SECONDS/DIV switch setting at the time SAVE REF was pressed is displayed. The field will be blank for all other settings of the SECONDS/DIV switch.

(5) 10 μs is displayed if the SWP MFG switch is pressed in and CURSORS switch is not in the OFF position.

CH 2 Scale Factor Readout Field

NOTE

In addition to the conditions given after each value or symbol, the following conditions also apply.

1. The ACQUISITION AND DISPLAY switch is in CH 2, ADD, DUAL or XY.

(6) > is displayed when the CH 2 CAL knob is not in the CAL position.

(7) - is displayed if the INVERT button is pressed in.

(8) 2V is the present CH 2 VOLTS/DIV switch setting when both SAVE and SAVE REF buttons are out and a 1X probe is used. If a 10X probe is used, 20 V will be displayed.

LEFT is displayed if the VOLTS/DIV switch is set to LEFT PLUG-IN.

If SAVE has been pressed, the CH 2 VOLTS/DIV switch setting at the time SAVE was pressed is displayed. Any subsequent change of the VOLTS/DIV switch setting will not change the readout until SAVE is released, at which time the new VOLTS/DIV switch setting will be displayed.

If SAVE REF has been pressed (SAVE out), the VOLTS/DIV switch setting at the time SAVE REF was pressed is displayed. The field will be blank for all other settings of the VOLTS/DIV switch.

Foldout for
Mainframe crt cursor readout fields generated by the 5D10
Figure 2-3

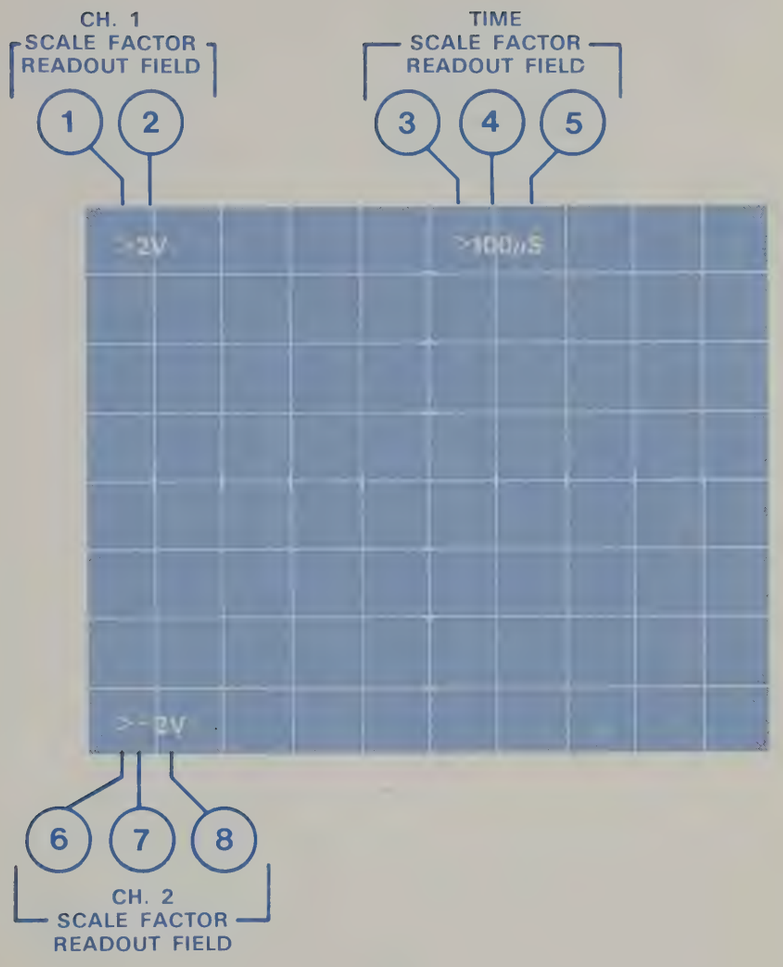


Figure 2-2. Mainframe crt scale factor readout fields generated by the 5D10.

SCALE FACTOR READOUT FIELDS

Refer to Figure 2-2 while proceeding through the following descriptions.

CH 1 Scale Factor Readout Field

NOTE

In addition to the conditions given after each value or symbol, the following conditions also apply.

1. The ACQUISITION AND DISPLAY switch is in CH 1, ADD, DUAL or XY.

(1) > is displayed when the CH 1 CAL knob is out of the CAL (detent) position.

(2) 2V is the present CH 1 VOLTS/DIV switch setting when both SAVE and SAVE REF buttons are out and a 1X probe is used. If a 10X probe is used, 20 V will be displayed.

If SAVE has been pressed, the CH 1 VOLTS/DIV switch setting at the time SAVE was pressed is displayed. Any subsequent change of the VOLTS/DIV switch setting will not change the readout until SAVE is released, at which time the new VOLTS/DIV switch setting will be displayed.

If SAVE REF has been pressed (SAVE out), the VOLTS/DIV switch setting at the time SAVE/REF was pressed is displayed. The field will be blank in all other settings of the VOLTS/DIV switch.

Time Scale Factor Readout Field

NOTE

This field is blank in XY mode. Refer to number 14 for more information.

(3) > is displayed when the SECONDS/DIV switch is in the UNCAL position.

(4) 100µs (Scale Factor) displays:

a. The present SECONDS/DIV switch setting when both the SAVE and SAVE REF buttons are out.

b. EXT, if external sample is selected.

If SAVE has been pressed, the SECONDS/DIV setting at the time SAVE was pressed is displayed.

If SAVE REF has been pressed (SAVE out), the SECONDS/DIV switch setting at the time SAVE REF was pressed is displayed. The field will be blank for all other settings of the SECONDS/DIV switch.

(5) 10 μs is displayed if the SWP MFG switch is pressed in and CURSORS switch is not in the OFF position.

CH 2 Scale Factor Readout Field

NOTE

In addition to the conditions given after each value or symbol, the following conditions also apply.

1. The ACQUISITION AND DISPLAY switch is in CH 2, ADD, DUAL or XY.

(6) > is displayed when the CH 2 CAL knob is not in the CAL position.

(7) – is displayed if the INVERT button is pressed in.

(8) 2V is the present CH 2 VOLTS/DIV switch setting when both SAVE and SAVE REF buttons are out and a 1X probe is used. If a 10X probe is used, 20 V will be displayed.

LEFT is displayed if the VOLTS/DIV switch is set to LEFT PLUG-IN.

If SAVE has been pressed, the CH 2 VOLTS/DIV switch setting at the time SAVE was pressed is displayed. Any subsequent change of the VOLTS/DIV switch setting will not change the readout until SAVE is released, at which time the new VOLTS/DIV switch setting will be displayed.

If SAVE REF has been pressed (SAVE out), the VOLTS/DIV switch setting at the time SAVE REF was pressed is displayed. The field will be blank for all other settings of the VOLTS/DIV switch.

Foldout for
Mainframe crt cursor readout fields generated by the 5D10
Figure 2-3

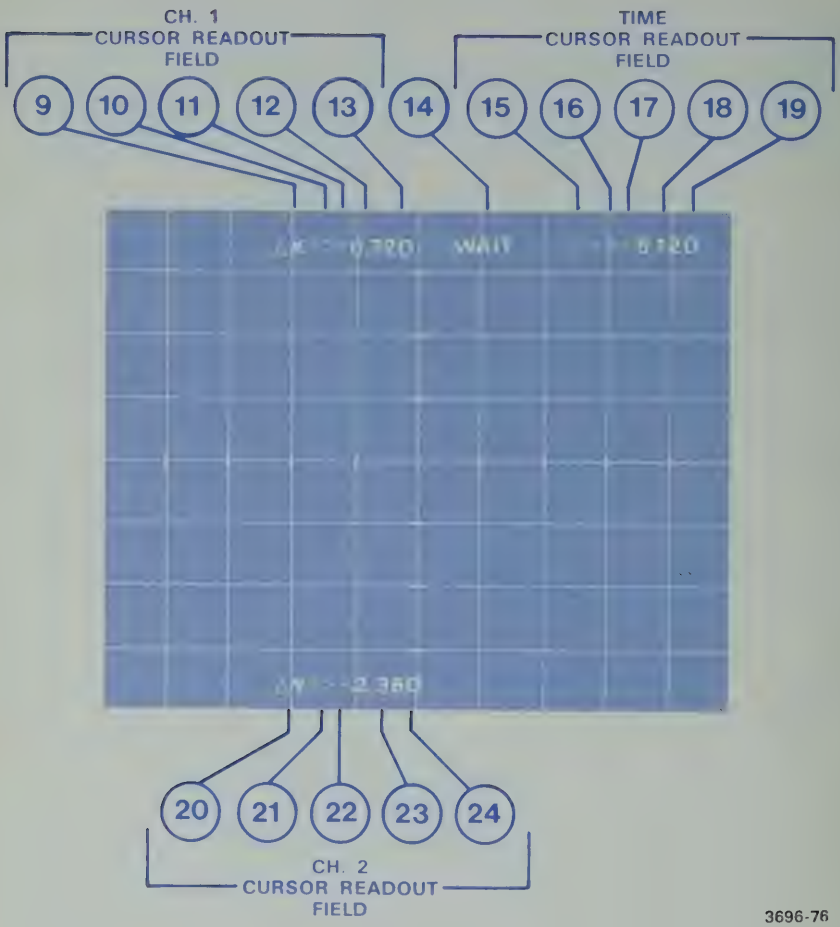


Figure 2-3. Mainframe crt cursor readout fields generated by the 5D10.

(22) – is displayed if the cursor value is below center screen or negative with respect to ground reference.

NOTE

See "Setting the Ground Reference" under Part II—Detailed Checkout Procedure later in this section.

(23) 2.36 (cursor value)

a. If CURSORS is in C1 position, the cursor value relative to ground reference or center screen is displayed.

b. If CURSORS is in C2-C1 position, the cursor value of C2-C1 is displayed.

(24) D (Divisions) is displayed when:

a. CH 2 ground reference has not been set since power up or the last scale factor change.

b. CAL knob not in CAL position.

V (Volts) is displayed when ground reference is set with cursor C1 on; also, the difference V is displayed when cursors C2-C1 are on.

CURSOR READOUT FIELDS

Refer to Figure 2-3 while proceeding through the following descriptions.

CH1 Cursor Readout Field

(9) ΔX= is displayed when X:CH1/Y:CH2 (ACQUISITION AND DISPLAY) is pressed and CURSORS switch is in C2-C1 position.

Δ= is displayed when CURSORS switch is in C2-C1 position.

X= is displayed when X:CH1/Y:CH2 (ACQUISITION AND DISPLAY) is pressed and CURSORS switch is in C1 position.

(10) > is displayed when a data point at which a cursor is to be displayed is off screen.

(11) – is displayed if the cursor value (see number 12) is below center screen or negative with respect to ground reference.

NOTE

See "Setting the Ground Reference" under Part II— Detailed Checkout Procedure later in this section.

(12) 0.72 (cursor value)

a. If CURSORS is in C1 position, the cursor value relative to ground reference or center screen is displayed.

b. If CURSORS is in C2-C1 position, the cursor value of C2-C1 is displayed.

c. In ADD mode, the cursor value relative to the ground reference of the added channels is displayed, or D (divisions) is displayed if ground reference is not acquired.

(13) D (Divisions) is displayed when:

a. The CH 1 ground reference has not been set since power up or the last scale factor change.

b. The CAL knob is not in CAL position.

c. Both LEFT PLUG-IN and ADD have been selected.

d. ADD is selected and CH 1 and CH 2 VOLTS/DIV switch settings are different.

V (Volts) is displayed when a ground reference is set with cursor C1 on; also, the difference V is displayed when cursors C2-C1 are on.

(14) WAIT is displayed after SAVE or SAVE REF has been pressed and until acquisition stops. Visible only at slow SECONDS/DIV switch settings. An ERASE will occur if any controls are switched during WAIT.

Time Cursor Readout Field

(15) Δ= is displayed when CURSORS is in C2-C1 position.

(16) > is displayed when a cursor is displayed greater than +500 points from center screen.

(17) – is displayed (CURSORS in C1 position) when the data point at which the cursor is displayed is prior to the selected TRIGGERING point (POST TRIG, CTR TRIG, PRE TRIG), or if cursor C2 is earlier than C1 (CURSORS in C2-C1 position).

(18) 5.12 (cursor value)

a. If CURSORS is in C1 position, the cursor value relative to the trigger point is displayed.

b. If CURSORS is in C2-C1 position, the cursor value of C2-C1 is displayed.

(19) D (Divisions) is displayed when (1) the SECONDS/DIV CAL knob is not in the CAL (detent) position (2) the SECONDS/DIV switch is in EXT otherwise μS, mS or S will be displayed. See number 18.

CH 2 Cursor Readout Field

NOTE

The CH 2 Cursor Readout Field is blank when in the ADD mode.

(20) ΔY= is displayed when X:CH1/Y:CH2 (ACQUISITION AND DISPLAY) is pressed and CURSORS switch is in C2-C1 position.

Δ= is displayed when CURSORS switch is in the C2-C1 position.

Y= is displayed when X:CH1/Y:CH2 (ACQUISITION AND DISPLAY) is pressed and CURSORS switch is in C1 position.

(21) > is displayed when a data point at which a cursor is to be displayed is off screen.

(22) – is displayed if the cursor value is below center screen or negative with respect to ground reference.

NOTE

See "Setting the Ground Reference" under Part II—Detailed Checkout Procedure later in this section.

(23) 2.36 (cursor value)

a. If CURSORS is in C1 position, the cursor value relative to ground reference or center screen is displayed.

b. If CURSORS is in C2-C1 position, the cursor value of C2-C1 is displayed.

(24) D (Divisions) is displayed when:

a. CH 2 ground reference has not been set since power up or the last scale factor change.

b. CAL knob not in CAL position.

V (Volts) is displayed when ground reference is set with cursor C1 on; also, the difference V is displayed when cursors C2-C1 are on.

OPERATORS CHECKOUT

The Operators Checkout procedures are provided for familiarization with the 5D10 and for checking basic instrument functions. The Operators Checkout is divided into two parts: Part I—Get Acquainted Exercise, and Part II—Detailed Checkout Procedure.

Part I—Get Acquainted Exercise is provided primarily for first time operation. The Get Acquainted Exercise leads the first time user through the basic 5D10 operating functions.

Part II—Detailed Checkout Procedure is provided for a detailed demonstration of 5D10 capabilities and to check instrument functions.

Refer to the description of the controls, connectors, and indicators given earlier in this section while performing these procedures. If performing the Part II—Detailed Checkout Procedure reveals a malfunction or possible maladjustment, refer qualified service personnel to the service manuals for maintenance and adjustment procedures.

POWER-UP SEQUENCE

The Power-Up Sequence must be performed prior to the Part I—Get Acquainted exercise or Part II—Detailed Checkout Procedure. The Power-Up Sequence lists the equipment required and provides the preliminary steps necessary to perform either procedure.

EQUIPMENT REQUIRED

The following test equipment is recommended for the Operators Checkout procedures. Other test equipment which meets these requirements may be substituted. When other equipment is substituted, the control settings or setup may need to be altered.

1. Oscilloscope

   Type Used: TEKTRONIX 5110 Oscilloscope. See Mainframe and Plug-In Compatibility considerations in Section 1, General Information.

2. Function Generator

   Description: Frequency range 1 Hz to 10 kHz; output amplitude, 15V p-p into 50 Ω.

   Type Used: TEKTRONIX FG501A, 2 MHz Function Generator (used with TM501 Power Module).

3. Amplifier Plug-In Unit

   Description: Two independent differential amplifiers in one plug-in, compatible with the Tektronix 5000-series Oscilloscope Mainframes.

   Type Used: TEKTRONIX 5A26 Dual Differential Amplifier.

4. Cables (2 Required)

   Description: Length 42 inches; connectors, bnc.

   Type Used: Type RG-58/U, 50-Ω coaxial, Tektronix part 012-0057-01.

5. T-Connector

   Description: Connectors, bnc-to-bnc.

   Type used: Bnc-to-bnc connectors, Tektronix Part 103-0030-00.

6. Terminator

   Description: Connector, bnc female to bnc male.

   Type used: 50 Ω, 2W, Tektronix part 011-0049-00.

7. Probe

   Description: Input resistance 10 MΩ, compensation 47 pF, connector, bnc.

   Type used: TEKTRONIX P6062B passive dual attenuation probe, Part 010-6062-13.

POWER UP SELF TEST

1. Install the 5D10 Waveform Digitizer in the right vertical and horizontal compartments of the oscilloscope mainframe.

2. Press SAVE, then turn on the oscilloscope mainframe power.

3. Set the oscilloscope mainframe Intensity control to midrange.

The 5D10 Waveform Digitizer automatically performs a Self Test each time power is applied to the instrument. At power-on, a reset signal is generated internally which initiates the running of a series of internal routines. These routines verify the proper operation of the waveform memory system and associated hardware.

If the 5D10 passes the self test and, if either or both SAVE or SAVE REF button(s) are in, the crt of the mainframe in which the 5D10 is installed will display a graticule, and, in the upper left corner, display '5D10 READY'. See Figure 2-4. If

neither SAVE nor SAVE REF has been pressed, the 5D10 will function in the normal fashion.

If an error is encountered an error message may be displayed on the crt.

The operator may ignore the error and attempt to continue normal operation by releasing the SAVE button or pressing, then releasing, the SAVE button if the SAVE button was not pressed in initially.

NOTE

Accuracy of measurements is not guaranteed if an error message is ignored.

Refer corrective action to qualified service personnel.

VERTICAL AND HORIZONTAL CENTERING

Minor correction in the vertical and horizontal centering of the display is accomplished with the VERT CTRG and HORIZ CTRG front-panel screwdriver adjustments.

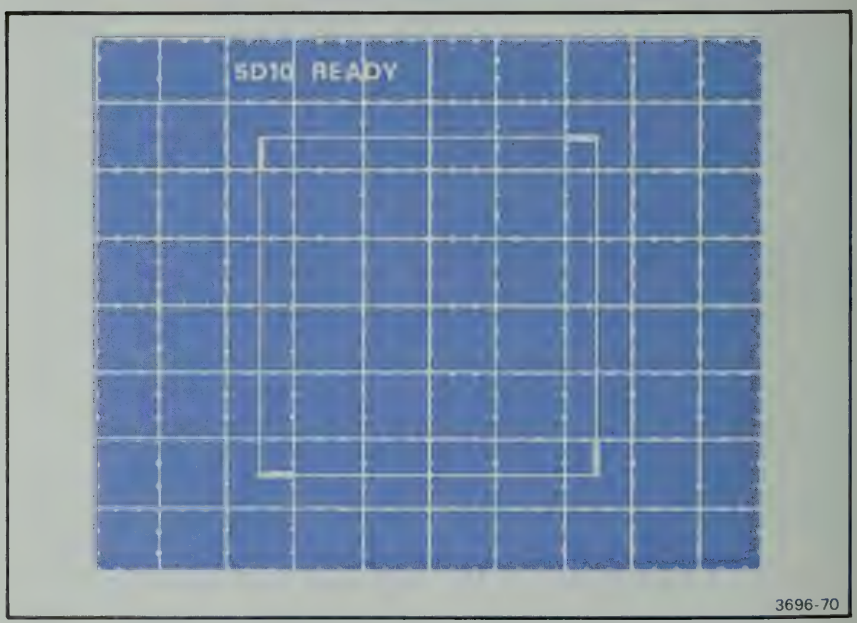


Figure 2-4. Power-up self test display graticule (passed message shown).

Proceed with the following instructions:

1. Adjust mainframe Intensity and Focus for a well defined display.

2. Adjust HORIZ CTRG so the 2nd and 10th displayed vertical graticule lines match the 2nd and 10th crt graticule lines.

3. Adjust VERT CTRG so the 2nd and 8th display horizontal graticule lines match the 2nd and 8th crt graticule lines.

4. Observe that the dots and vectors match and that the corners of the box pattern are in line. Refer to Figure 2-4.

NOTE

If the horizontal and vertical display requirements cannot be met using the front-panel adjustments, refer corrective action to qualified service personnel.

The instrument can be used; however, measurement accuracy and full function capability is not guaranteed.

OPERATORS CHECKOUT SETUP

The Operators Checkout Setup must be completed prior to performing either the Part I—Get Acquainted Exercise or the Part II—Detailed Checkout Procedure.

1. Set the 5D10 controls as follows:

TRIGGERING
- POSITION ..... CTR TRIG
- SLOPE ..... ⌠ (+ slope)
- LEVEL ..... Midrange
- COUPLING ..... AC
- SOURCE ..... CH 1

SECONDS/DIV ..... 0.1 m
- CAL ..... Fully clockwise (in detent)

CURSORS ..... OFF
- SWP MGF ..... Off (button out)

VOLTS/DIV (CH 1) 0.5

STORAGE
- VIEWTIME ..... MIN (fully counterclockwise)
- SAVE ..... Off (button out)
- SAVE REF ..... Off (button out)

Input Coupling (CH 1) ..... AC (button in)
- GND ..... button out

ACQUISITION AND DISPLAY
- CH 1 ..... On (button in)
- JOIN DOTS ..... On (button in)

SAVED DISPLAY OUTPUT
- PLOT ..... Off (button out)

2. Turn on the function generator.

3. Adjust the intensity and focus for a well-defined display. See the oscilloscope mainframe instruction manual for detailed operating instructions.

Proceed to Part I—Get Acquainted Exercise or Part II—Detailed Checkout Procedure.

PART I—GET ACQUAINTED EXERCISE

The Part I—Get Acquainted Exercise is provided primarily for first time operation. The exercise leads the first time user through the basic operation of the 5D10. Refer to Part II—Detailed Checkout Procedure for a detailed demonstration of 5D10 capabilities and to check for correct operation of instrument functions.

1. ACQUIRING A SIGNAL

Once a signal has been acquired (that is sampled, digitized, and stored into memory) and displayed on the crt, the 5D10 has the information necessary to perform selected functions as determined by front-panel control settings. Such features include scale factor readout (signal acquisition not requried for scale-factor readout), stored displays on the crt, point-to-point cursor measurements with values displayed on crt readout, etc.

SETUP — Perform the Operators Checkout Power-Up Sequence.

Set the 5D10 controls as follows:

TRIGGERING POSITION ..... FREE RUN
SECONDS/DIV 0.2
POS..... Vertically Centered

Connect an approximate 1-volt (2 divisions) 5-hertz sine-wave signal from the function generator to the 5D10 CH 1 input with a coaxial cable and 50-ohm termination.

OBSERVE — 500 mV readout corresponding to the 0.5 CH 1 VOLTS/DIV setting.

200 ms readout corresponding to the 0.2 SECONDS/DIV setting.

SETUP — Vary the function generator amplitude.

OBSERVE — The acquired display moves from right to left with the most recently acquired data at the right of the crt display.

2. SELECTING THE TRIGGERING POSITION

The TRIGGERING POSITION buttons provide three choices to select the triggering position on the displayed waveform. (1) In the PRE TRIG position the display occurs before the triggering event. (2) In the CTR TRIG position one-half the display occurs before the triggering event and one-half the display occurs after the triggering event. (3) In the POST TRIG position the display occurs after the triggering event. An intensified dot on the displayed waveform denotes the triggering point.

SETUP Set the function generator amplitude for a two-division display.

Set the 5D10 controls as follows:

POS.....Vertically centered on crt
SECONDS/DIV ..... 10 m
VIEWTIME.....Midrange
TRIGGERING
POSITION ..... CTR TRIG
LEVEL..... TRIG'D light on

OBSERVE Triggered sine-wave display with an intensified dot (trigger point) near crt center. The display to the left of the trigger point is acquired before the triggering event and the display to the right of the trigger point is acquired after the triggering event.

SETUP Set the TRIGGERING POSITION to PRETRIG.

OBSERVE The intensified dot (trigger point) is displayed at the right side of display area. The display to the left of the trigger point is acquired before the triggering event. Pretrigger is unique to digital storage.

SETUP Set the TRIGGERING POSITION to POST TRIG.

OBSERVE The intensified dot (trigger point) is displayed at left side of the display area. The display to the right of the trigger point is acquired after the triggering event. Post Trigger is common to conventional oscilloscope triggering.

3. STORING A WAVEFORM

After signals have been stored into memory, the display may be stored on the crt display by simply pressing the SAVE button. When the SAVE button is released the crt is blanked and a new signal is acquired and displayed for a time determined by the VIEWTIME control.

SETUP Press SAVE (button in).

OBSERVE The 5-hertz signal is now stored on the crt.

4. USING DISPLAY CURSORS

Cursors are provided for waveforms stored on the crt (SAVE mode) to delimit or identify portions of the waveform to be measured. The cursors can be positioned to the desired points on the display by use of the appropriate front-panel controls. The cursor values are displayed on the crt readout.

SETUP Set the 5D10 controls as follows:

TRIGGERING POSITION ..... CTR TRIG
CURSORS C2-C1
SECONDS/DIV ..... 1 m
SAVE ..... Off (button out)
VIEWTIME ..... MIN

Set the function generator for a 2 division 1 kHz output.

Press SAVE (button in).

OBSERVE The 1 ms display is now stored on crt.

SETUP Press C1 cursor motion switch to the left and then to the right.

OBSERVE The cursor moves on displayed waveform to the left and right respectively.

SETUP Move Cursors C1 and C2 to be approximately 4 divisions horizontally apart.

OBSERVE △ time readout of approximately △ = 4.00 mS (1 ms SECONDS/DIV setting times approximately 4 horizontal divisions between cursors results in delta time of approximately 4.00 mS).

SETUP Set the function generator for square-wave output.

Release SAVE (button out) so that the square-wave signal may be acquired.

Set the SECONDS/DIV to 0.2 m.

Press SAVE (button in) to store the square wave.

Position Cursor C1 to the bottom of the square wave and move Cursor C2 to the top of the square wave.

OBSERVE Channel 1 cursor field readout for delta volts readout of approximately △ 1.00 V (0.5 CH 1 VOLTS/DIV setting times the approximate 2 division vertical step of the square-wave signal results in delta volts reading of approximately 1 volt).

SETUP Set CURSORS to C1.

Ensure that the TRIGGERING POSITION is set to CTR TRIG.

Position cursor C1 to the intensified dot at the trigger point.

OBSERVE The delta time readout has been replaced with a readout display of approximately 0 μs. With CURSORS switch in C1 position, the readout corresponds to the time between cursor C1 and the trigger point.

SETUP Move cursor C1 to the left of the trigger point.

OBSERVE The time-cursor readout increases in the negative direction (e.g., −122 μs).

SETUP Move cursor C1 to the right of the trigger point.

OBSERVE The time-cursor readout increases in the positive direction (e.g., 136 μs).

5. OBTAINING A SAVE REFERENCE DISPLAY

The SAVE REF function allows comparison of two traces. A stored display from previously acquired data can be compared to the information presently being acquired and displayed (the display time of the new data is determined by the setting of the VIEWTIME control).

SETUP Set the 5D10 controls as follows:

SAVE ..... Off (button out)
SECONDS/DIV ..... 5 m (Allow 1 ms signal to be acquired)
SAVE REF.....On (button in)
TRACE SEP .....On (button in)
SECONDS/DIV .....0.5 m

OBSERVE The 1 ms reference display is stored on the crt and a new acquired signal is displayed (approximately 1 cycle in 2 divisions).

6. SETTING GROUND REFERENCE

When making voltage measurements in the C1 CURSORS switch position all cursor measurements are relative to the ground reference. The ground reference may be set at any point within five divisions of the center horizontal graticule line. Or, if the ground reference is not set, it will default to the center horizontal graticule line.

SETUP Set the 5D10 controls as follows:

SECONDS/DIV .....0.2 m
SAVE REF..... Off (button out)
TRACE SEP ..... Off (button out)

Increase the function generator amplitude for a 4-division display vertically centered on the crt.

Engage the SAVE button to store the display on the crt.

Move cursor C1 to the top of square-wave step.

OBSERVE The channel 1 cursor field readout of approximately 2.00D (divisions) relating to 2 divisions from center screen. When the ground reference has not been set, the CH 1 cursor field readout is measured from crt center in divisions.

SETUP Set 5D10 controls as follows:

CH 1 input coupling..... GND (button in)
SAVE ..... Off (button out)

Position the horizontal trace to 1 division above crt center.

Set the 5D10 controls as follows:

ERASE ..... Press and release
CH 1 input coupling..... GND off (button out)
SAVE .....On (button in)

OBSERVE The CH 1 cursor field readout has changed to volts with an approximated reading of 1.00 V. The 1-volt reading corresponds to 2 divisions above ground reference at 0.5 VOLTS/DIV.

This ends the 5D10 short form Part I—Get Acquainted Exercise. If a more detailed exercise of the 5D10 features is desired, continue with Part II—Detailed Checkout Procedure.

PART II—DETAILED CHECKOUT PROCEDURE

The Part II—Detailed Checkout Procedure provides a systematic demonstration of all the front panel controls. Further information about certain controls can be found in the Detailed Operating instructions that follow. Refer to the front-panel Controls, Connectors and Indicators foldout given earlier in this section while performing this procedure for additional information.

If performing this checkout procedure reveals a malfunction or possible maladjustment, refer qualified service personnel to the service manual for maintenance and adjustment procedures.

SETUP

To begin with Part II—Detailed Checkout Procedure, first perform the Power-Up Sequence. Then proceed to Setting the Ground Reference procedure, which follows.

To proceed from Part I—Get Acquainted Exercise perform the Operators Checkout setup (part of Operators Checkout Power-up Sequence) then proceed to Setting the Ground Reference procedure.

Setting the Ground Reference

When making voltage measurements with the CURSORS switch in the C1 position, all voltage readouts are relative to ground reference.

NOTE

At power up, the graticule is calibrated in divisions (D) with the center graticule line the zero level (reference).

The following procedure should be used when setting the ground reference:

1. Press GND of the appropriate channel (CH 1 or CH 2).

NOTE

The ADD mode requires both GND pushbuttons pressed in and the same VOLTS/DIV switch settings.

2. Press FREE RUN, then adjust the trace(s) to the desired position.
3. Press PUSH: ERASE button then release the GND pushbutton.
4. The ground reference has now been stored in memory.

GND reference values become invalid and need to be re-acquired for the following conditions:

- CH 1 or CH 2 VOLTS/DIV switch setting is changed (affects only that channel's GND reference; however, in ADD mode a change in either will cause both to be lost).

- The CH 1 or CH 2 CAL knob is changed to or from the CAL position (affects only that channel's GND reference; however, in ADD mode a change in either will cause both to be lost).

- The CH 2 INVERT switch is changed to or from the INVERT position (affects only CH 2 GND reference; however, in ADD mode a change in the INVERT switch setting will cause both to be lost).

- ADD (ACQUISITION AND DISPLAY) is selected or deselected (affects both channel 1 and channel 2 ground references).

  Adjustment of the POSition knob will affect the cursor values relative to the GND reference, so a new ground reference should be acquired after each position adjustment.

NOTE

The 5D10 will not acquire a ground reference more than ±5 divisions from center screen.

The readout will display [D]ivisions rather than [V]olts if the ground reference is invalid.

Sweep Functions

NORMAL SWEEP

Perform the following procedure to obtain a normal sweep and to demonstrate the function of the related controls:

1. Connect a 1-volt, 1-kilohertz (approximately) signal from the function generator to the CH 1 input. Rotate the amplitude control of the function generator until a two-division signal is displayed. Set TRIGGERING POSITION to CTR TRIG.

2. Adjust the LEVEL/SENSITIVITY control for a triggered display.

3. Rotate the VIEWTIME control slowly in the clockwise direction. Notice the time is increased between erase operations (blank screen). The VIEWTIME controls the time the waveform is displayed before being erased and new data acquired and displayed.

4. Press PUSH:ERASE. Notice the display is blanked then new data acquired and displayed without changing the VIEWTIME setting.

5. Rotate VIEWTIME to MIN (fully counterclockwise), and check that the SWP MGF button is released (out).

6. Press each POSITION (TRIGGERING) control in turn (POST TRIG/CTR TRIG/PRE TRIG). Notice the trigger indicator 'dot' jumps to the left of center screen approximately 4 divisions, to center screen, then, approximately 4 divisions to the right of center screen.

7. Switch SECONDS/DIV to 0.1 and disconnect the function generator.

8. Rotate the CH 1 POSition control and observe that the trace moves vertically. The most recently acquired data is displayed at the right most point on the crt display.

9. Connect a 10 hertz signal from the function generator to the CH 1 input. Press CTR TRIG. Turn the CAL control fully counterclockwise and observe that the displayed waveform sweep rate is continuously variable between SECONDS/DIV switch settings. Turn the CAL knob to the calibrated (detent) position.

   Return the function generator output frequency to 1 KHz.

NOTE

The symbol > (greater than) in the readout indicates uncalibrated settings.

EXTERNAL SWEEP

10. Disconnect the 1 kHz signal from CH 1 input and connect it to the EXTERNAL SEC/DIV input connector.

11. Switch SECONDS/DIV to EXT (fully counterclockwise).

12. Connect a 1X probe (see Equipment Required list) to the CH 1 input and to the mainframe calibrator loop.

13. Increase the amplitude of the function generator if the displayed signal does not trigger.

14. Rotate the frequency multiplier of the function generator. Observe that an external signal will control the sample rate.

POSSIBLE UNDERSAMPLING INDICATOR

15. Disconnect the probe from the calibrator loop and the CH 1 input connector.

16. Disconnect the signal to the EXTERNAL SEC/DIV input and connect it to the CH 1 input.

17. Switch SECONDS/DIV to 0.1 m.

18. Provide a 1 kHz, 1 volt signal from the function generator.

19. Turn the SECONDS/DIV control counterclockwise 1 step at a time. Notice that when the switch is in the 20 m and slower positions the POSSIBLE UNDERSAMPLING indicator lights (red indicator). The POSSIBLE UNDERSAMPLING indicator shows that the system is taking too few samples to accurately reconstitute the input signal.

MAGNIFIED HORIZONTAL SWEEP (SWP MGF)

20. Switch SECONDS/DIV to 1 m.

21. Switch CURSORS to the C1 position.

22. Press SAVE, then press the SWP MGF button (button in). Observe that approximately 1 cycle is magnified to about 10 divisions.

    The part of the unmagnified display that will be enlarged is that portion immediately preceding (1/8) and following (7/8) the position of cursor C1. Refer to Figure 2-5.

    Once SWP MGF is pressed, moving C1 in the desired direction will allow the operator to control the portion of the original waveform that is displayed.

    The readout will reflect the new scale factor (SECONDS/DIV setting ÷ 10).

23. Press SWP MGF (button out) and switch CURSORS to OFF.

Readout

SCALE FACTOR SETTINGS

24. Rotate the CH 1 VOLTS/DIV switch throughout its range.

    a. Notice the CH 1 scale factor readout (500 mV) remains unchanged because the SAVE function is engaged.

25. Release SAVE then press SAVE REF. Press TRACE SEP button (in).

    a. Notice while rotating the SECONDS/DIV control that the SECONDS/DIV readout display occurs only when the stored time and new time are the same, otherwise the SECONDS/DIV readout is blanked.

    b. Notice that the display continues to update, (unlike pressing the SAVE button) over the reference waveform.

    c. Notice that the repetition rate of the new trace changes as the SECONDS/DIV switch is rotated, while the reference waveform remains unchanged.

26. Release, then press SAVE REF; the reference waveform will update to the new SECONDS/DIV setting. Release SAVE REF.

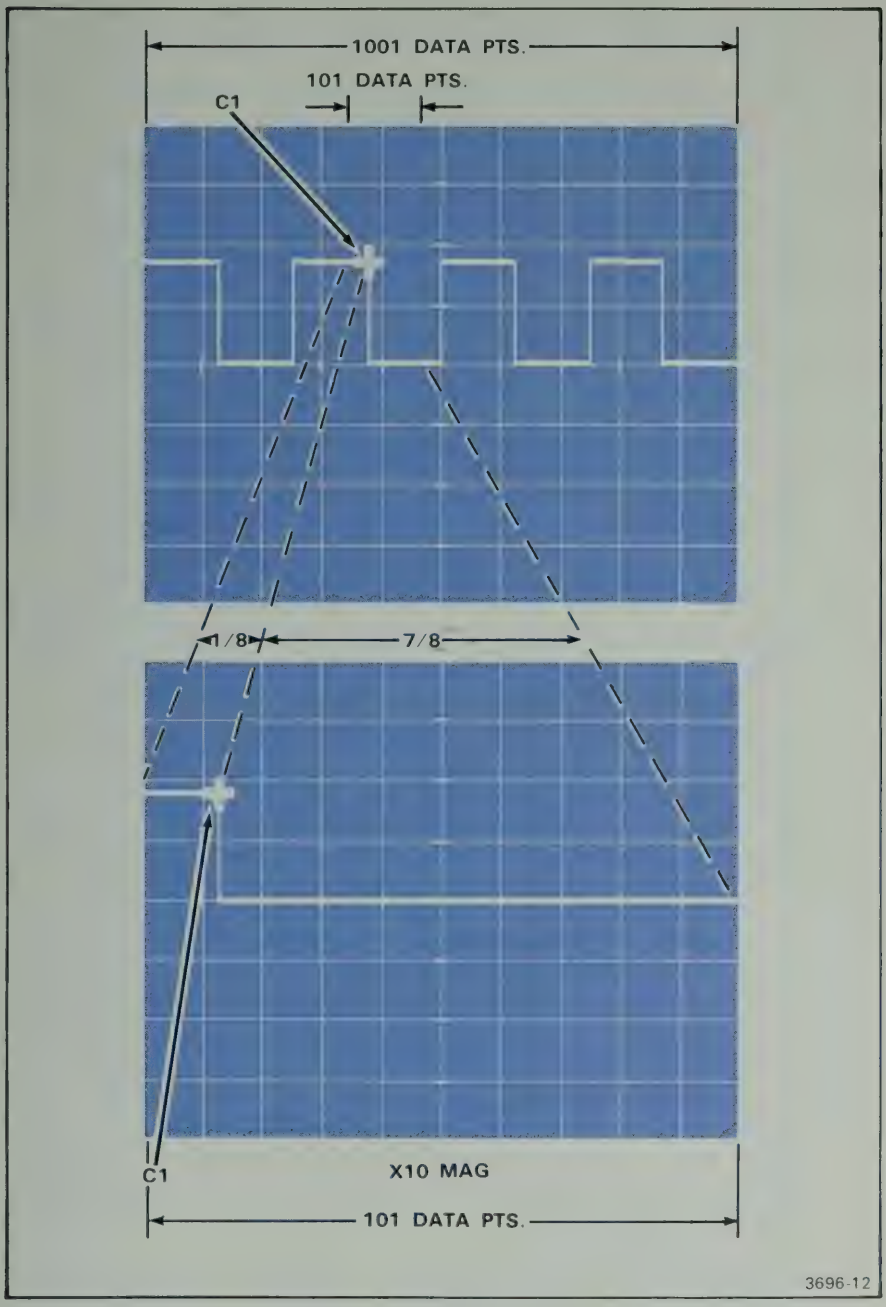


Figure 2-5. Sweep magnify.

27. Set the ACQUISITION AND DISPLAY to CH 2, then set the CH 2 VOLTS/DIV to LEFT PLUG-IN.

    a. Notice that the readout at the bottom left corner of the screen displays LEFT (the left plug-in unit is not installed at this time).

    b. Set the CH 2 VOLTS/DIV to 0.5 and return the ACQUISITION AND DISPLAY to CH 1.

Triggering Functions

Perform the following procedure to obtain a triggered display and to demonstrate the functions of the related controls:

INTERNAL TRIGGERING

28. Return the SECONDS/DIV switch to 1 m.

29. Turn the LEVEL/SENSITIVITY control to obtain a freerunning (not triggered) display. Then set the LEVEL/SENSITIVITY control for a stable display (TRIG'D light on).

30. Press the AC and DC COUPLING button for both the ⎍ and ⎏ positions of the SLOPE switch and check for a triggered display. The LEVEL/SENSITIVITY control may be adjusted to obtain a triggered display (TRIG'D light on).

31. Press FREE RUN. Observe that the display is freerunning (not triggered) and the TRIG'D light remains on. Press CTR TRIG.

EXTERNAL TRIGGERING

32. Apply a 1-volt, 1-kilohertz signal from the Function Generator to the EXTernal SOURCE connector, and to the CH 1 input connector.

33. Press in the EXT (TRIGGERING SOURCE) button.

34. Set the SLOPE control to BISLOPE (both SLOPE buttons in). Turn the LEVEL/SENSITIVITY control to the MAXimum position (fully counterclockwise). Observe that the signal is triggered.

35. Turn the LEVEL/SENSITIVITY control towards the MINimum position (clockwise).

    Observe that the display becomes untriggered and is freerunning. The adjustment between this point and maximum is the sensitivity threshold "window" of the BISLOPE mode.

36. Adjust the LEVEL/SENSITIVITY control for a triggered display and press the STORAGE VIEWTIME (PUSH:ERASE) button. Note that the trace disappears when the button is depressed and reappears when it is released, (updated with the latest points in memory.)

37. Press CH 1 (TRIGGERING SOURCE) and disconnect the external triggering signal.

NOTE

For more information, see Triggering in Detailed Operating Instructions.

38. Connect the 1-volt, 1-kilohertz signal from the function generator to the CH 1 input connector. Adjust the TRIGGERING LEVEL control for a triggered display, and vertically center the display.

Cursors

YT MODE

39. Press SAVE (button in) then switch CURSORS to C1 position.

40. Notice that cursor C1 is displayed on the waveform.

NOTE

Cursors are normally displayed as a +.

If a data point at which a cursor is to be displayed is off screen horizontally the cursor is displayed as a horizontal bar. If a data point at which a cursor is to be displayed is offscreen vertically the cursor is displayed as a vertical bar.

If both cases are true, then an intensified dot is displayed. When the cursor is displayed as something other than a + (dot, vertical or horizontal bar) then the cursor field readout will display a ≥ symbol.

When <C1> is activated, C1 will move 1 data point in the indicated direction. Notice that the rate increases as the switch is held in position.

41. Move the cursor to the left-most graticule position. Notice the cursor appears as a horizontal bar.

42. Switch CURSORS to C2-C1 position.

43. Move the cursor C1 one graticule division from the left. Using C2 cursor motion switch, move C2 to the left. Notice that C2 will not move past C1. Move C1 to the right. Notice the C1 will move C2.

44. Place cursor C1 and C2 one cycle apart on the center horizontal graticule line. Notice the readout △=1.00 mS (approximately).

45. Move cursor C1 to the bottom of the waveform. Notice the readout △ = 0.50 V (500 mV/div).

46. Release SAVE (button out).

XY MODE

Connect a T-connector (bnc) to the output of the Function Generator, and connect the output to both CH 1 and CH 2 inputs (5D10). Set the output frequency to 10 Hz (approximately), and CH 2 VOLTS/DIV to 0.5.

47. Switch SECONDS/DIV to 50 m, then adjust the amplitude of the function generator for a 2 division display.

48. Center the display vertically.

49. Press CH 2 (ACQUISITION AND DISPLAY), then center the display vertically.

50. Press CH 2 AC/DC (input coupling) to AC (button in).

51. Press X:CH1/Y:CH2.

    Observe the vector at approx 45°. Press SAVE. Switch CURSORS to C2-C1. Notice that C1 and C2 move the length of the vector and that C2 will not stop at C1; also C1 will not move C2 as in YT mode.

52. Release SAVE.

53. Press CH 2 AC/DC (input coupling) to DC (button out).

54. Observe the oval XY display.

NOTE

Refer to Phase Measurements in Section 3, Applications, for more information about the XY mode.

Obtaining a Multiple Trace Display

Perform the following procedure to demonstrate dual trace displays, and use of the Left Plug-In.

NOTE

The maximum frequency that can be reconstructed accurately is limited by the number of traces to be displayed at any one time. Refer to Table 2-2, Measurement Frequency Limitations, at the end of this section.

TWO-TRACE DISPLAY (DUAL MODE)

55. Perform the "Operators Checkout Setup" given at the beginning of the Operators Checkout Procedure.

56. Set the function generator to display 2 divisions of amplitude at a frequency of 1 kHz.

57. Set the SECONDS/DIV to 1 m, and position the CH 1 display to the top half of the graticule.

58. Set the ACQUISITION AND DISPLAY to CH 2, and the CH 2 VOLTS/DIV to 1. Position the CH 2 display to the bottom-half of the graticule.

59. Set the ACQUISITION AND DISPLAY to DUAL. Notice that the Channel 1 and Channel 2 signals are displayed simultaneously.

60. Press SAVE (button in) and set the CURSORS to C1.

    a. Notice that cursor C1 is displayed on both the Channel 1 and Channel 2 traces at the same horizontal point.

    b. Notice that the cursor voltage readout is displayed at the top of the screen for Channel 1, and at the bottom of the screen for Channel 2.

61. Move cursor C1 across the display area.

    a. Notice that the cursor time readout (refer to Fig. 2-3) corresponds to the time (+ or −) from the trigger point (intensified dot).

    b. Notice the cursor voltage readout (refer to Fig. 2-3) for both Channel 1 (top) and Channel 2 (bottom) with respect to the ground reference.

NOTE

When the ground reference has not been set, the cursor voltage readout for both Channel 1 (top) and Channel 2 (bottom) is the distance in divisions, from the crt vertical center.

The ground reference can be set individually for Channel 1 and Channel 2, (see Setting the Ground Reference, at the beginning of the Detailed Checkout Procedure). When the ground reference has been set, the cursor voltage readout will corresond to the voltage difference between the cursor and the appropriate ground reference, (i.e., 0.72 V).

62. Set CURSORS to C2-C1. Position cursors C1 and C2 approximately 3.5 divisions apart.

    a. Notice that cursors C1 and C2 are displayed at the same horizontal points on their respective waveforms.

    b. Notice that the cursor time readout corresponds to the time difference between cursors C1 and C2 (i.e., 3.5 divisions between cursors and a SECONDS/DIV setting of 1 m corresponds to a cursor time readout of △ = 3.50 mS).

    c. Notice that the cursor voltage readout for Channel 1 is displayed at the top of the screen, and Channel 2 is displayed at the bottom. The cursor voltage

readout is the algebraic difference between cursors C1 and C2 (i.e., △ = −0.26 V). Release SAVE (button out).

63. Press the SAVE REF button in, then press the TRACE SEP button in. Set the CH 1 VOLTS/DIV to 1, the CH 2 VOLTS/DIV to 2, and the SECONDS/DIV to 2 m.

    a. Notice that the scale readouts for time and voltage are blanked. When the scale factors for the reference displays and the new displays differ, neither scale factor is displayed.

    b. Notice that the cursor voltage and cursor time readout displays correspond to the reference (saved) display.

    c. Press SAVE (button in). Move the C1 Cursor motion switch to alternate the cursors between the new and reference displays.

    d. Notice that the cursor readout reflects the appropriate VOLTS/DIV settings as the cursors are moved between the new and reference displays.

TWO-TRACE DISPLAY (LEFT PLUG-IN MODE)

64. Turn oscilloscope mainframe power off.

65. Install an amplifier plug-in unit in the left vertical compartment of the oscilloscope mainframe. (Refer to Amplifier Unit Manual for operating instructions.)

NOTE

Refer to Mainframe Compatibility and Plug-In Compatibility in Section 1, General Information, before using the 5D10 Left Plug-In mode.

66. Turn on oscilloscope mainframe power.

67. Release the SAVE, SAVE REF and TRACE SEP buttons (out), set ACQUISITION AND DISPLAY to CH 2, set CH 2 VOLTS/DIV to 20, and push CH 2 GND.

68. Center the trace with the CH 2 POSition control. Do not disturb this setting throughout the remainder of the "Two Trace Display" procedure.

69. Switch CH 2 VOLTS/DIV to LEFT PLUG-IN. Notice that LEFT is displayed in the scale factor readout position on the screen. Set the amplifier unit controls (dual amplifier unit installed in the left vertical compartment) for a Channel 1 display.

70. Vertically position the left plug-in trace (with its Ch 1 Position control) to the bottom-half of the screen. Set the left plug-in CH 1/Volts/Division to 2 volts.

71. Move the 1 kHz signal from the 5D10 CH 2 input connector to the CH 1 input of the left plug-in unit.

72. Set the ACQUISITION AND DISPLAY to DUAL. Notice that the CH 1 and left plug-in signals are displayed simultaneously.

    Cursor and Save Reference functions are the same as those described in steps 60 through 63 of the "Two-Trace Display (Dual Mode)" instructions, except that CH 2 cursor readout is always in divisions (D) from screen center.

THREE-TRACE DISPLAY (LEFT PLUG-IN MODE)

A three trace display can be achieved with a dual-trace amplifier unit installed in the left plug-in compartment of the oscilloscope mainframe.

73. Connect a 1 kHz signal to the 5D10 CH 1 input, and to both inputs of the dual-trace amplifier unit (in left plug-in compartment of the oscilloscope mainframe). Set the dual-trace amplifier for dual-trace operation; position traces as necessary.

    a. Press the SAVE button (in).

    b. Observe a three-trace display on the screen.

    c. Note that the cursors on the dual-trace portion of the display (from the left plug-in unit) are shared between the two traces. Cursor measurements can be made on any of the displayed waveforms. Care should be exercised on either of the left plug-in traces to ensure that both cursors are on the trace to be measured.

74. Release SAVE (button out). Press SAVE REF and TRACE SEP (buttons in). Notice that three reference traces and three newly acquired traces are displayed. Position the trace as necessary. Press SAVE button in.

    Cursor measurements can be made on any of the displayed waveforms. Care should be exercised to ensure that both cursors are on the proper trace to be measured.

75. Release the SAVE, SAVE REF, and TRACE SEP (buttons out). Set the ACQUISITION AND DISPLAY to X:CH1/Y:CH2.

    a. Observe a two-vector display; the 5D10 CH 1 input provides the X-axis for both vectors, and the left plug-in dual amplifier unit provides the Y-axis inputs. One Y-axis is input through Channel 1, and the other Y-axis is input through Channel 2 of the left plug-in unit.

This completes the Part II—Detailed Checkout Procedure.

DETAILED OPERATING INSTRUCTIONS

SIGNAL CONNECTIONS

Probes

Generally, probes offer the most convenient means of connecting input signals to the instrument. They are shielded to prevent pickup of electromagnetic interference, and the 10X probe offers a high input impedance that minimizes circuit loading. This allows the circuit under test to operate with a minimum of change from the normal condition of the circuit when measurements are being made. Signal amplitude is attenuated by a factor of 10 by the probe, and the scale-factor readout is switched to indicate the correct scale factor.

Probe Compensation. Maladjustment of probe compensation is one of the sources of measurement error. Most attenuator probes are equipped with a compensation adjustment. To ensure optimum measurement accuracy, always compensate the oscilloscope probe before making measurements. Probe compensation is acomplished as follows:

NOTE

The range of adjustment of the probe compensation network must be compatible with the input capacitance of the 5D10 (47 pF).

1. Connect a 10X probe to the channel(s) to be used.

NOTE

Recommended probes are TEKTRONIX P6105 (10X) and P6062B (Selectable, 1X or 10X).

2. Set the VOLTS/DIV switch to 10 m, the input coupling to DC, and the SECONDS/DIV to 5 ms.

3. Connect the probe attached to the input bnc connector to the oscilloscope calibrator loop.

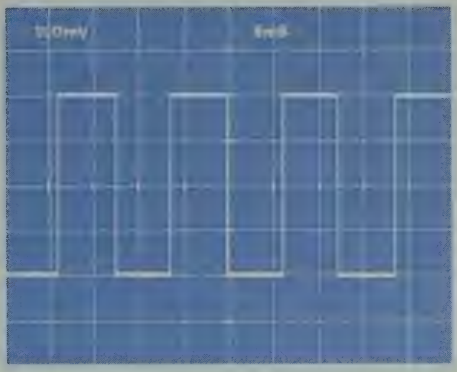
4. Obtain a triggered display of several cycles of the Calibrator signal.

5. Check the waveform presentation for overshoot and rounding (see Fig. 2-6B, C). Readjust the probe compensation, if necessary, for flat tops on the waveforms (Fig. 2-6A). Refer to the instructions supplied with the probe for the compensation adjustment procedure.

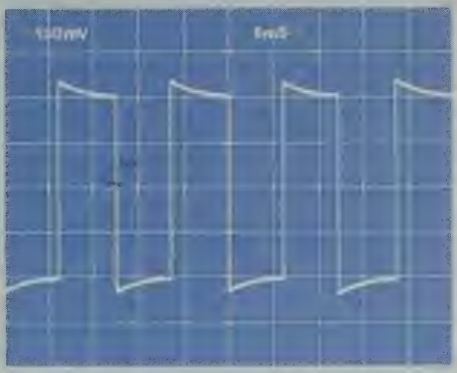
NOTE

Pause following each increment of the compensation adjustment to allow the memory to update and display the new data.

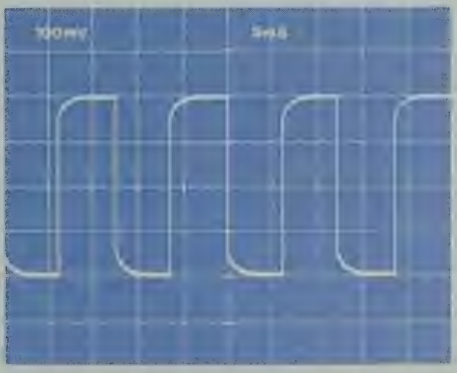
A
COMPENSATED
(CORRECT)



B
OVERCOMPENSATED
(OVERSHOOT)



C
UNDERCOMPENSATED
(ROUNDING)



3696-73

Figure 2-6. Probe compensation.

Coaxial Cables

Cables also may be used to connect signals to the input connectors, but they may have considerable effect on the accuracy of the displayed waveform. To maintain the original frequency characteristics of an applied signal, use only low-loss, high-quality coaxial cable. Also, cables should be terminated at both ends in the characteristic impedance. If this is not possible, use suitable impedance-matching devices.

INPUT COUPLING CAPACITOR PRECHARGING

With GND and AC depressed, the input signal is connected to ground through the coupling capacitor and a high resistance to form a precharging network for the coupling capacitor. This network allows the input coupling capacitor to change to the average dc-voltage level of the signal applied to the probe. Thus, large voltage transients are not generated that could be applied to the amplifier input when the input coupling is switched from GND to AC. The precharging network also provides a measure of protection to the external circuitry by reducing the current levels that can be drawn from the external circuitry during coupling capacitor charging.

If AC input coupling is used, the following procedure should be followed whenever the probe tip is connected to a signal source having a different dc level than that previously applied. This procedure becomes especially useful if the dc level difference is more than 10 times the VOLTS/DIV switch setting.

1. Press GND before connecting the probe tip to a signal source.
2. Touch the probe tip to the oscilloscope chassis ground.
3. Wait several seconds for the input coupling capacitor to discharge.
4. Connect the probe tip to the signal source.
5. Wait several seconds for the input coupling capacitor to charge.
6. Release GND (button out). A signal with a large dc component can be vertically positioned within the graticule area, and the ac component of the signal can be measured in the normal manner.

TRIGGERING

Triggering Logic

The operation of the triggering logic can be modified (TRIGGERING not set to FREERUN) by moving a jumper.

NOTE

Only qualified service personnel can make changes to jumper position. Qualified service personnel refer to the service manual.

The two jumper positions are First Trig and Full Disp. In first trigger position acquisition stops after recognition of the first trigger event following an erase.

NOTE

A partial trace may be displayed due to insufficient time to acquire data between pressing erase and the first trigger event.

In the Full Disp position a full horizontal trace will be displayed after an erase. Any triggering event which occurs prior to acquiring a full horizontal trace will be disqualified. The 5D10 is shipped from the factory with the jumper in the FULL DISP position.

LEVEL/SENSITIVITY Control

The TRIGGERING LEVEL/SENSITIVITY control has two functions, both of which depend on the position of the SLOPE selector pushbuttons.

When the SLOPE selector is set to ⌠ (+) or ⌡ (−), the LEVEL/SENSITIVITY control functions as a LEVEL control. See Figure 2-7A, B. Rotating the LEVEL control clockwise selects a more positive part of the input signal as the trigger point.

When the SLOPE selector is set to BISLOPE (both pushbuttons in) the LEVEL/SENSITIVITY control functions as a SENSITIVITY control. The counterclockwise extreme is MAXimum sensitivity, and the clockwise extreme is MINimum sensitivity.

The adjustable sensitivity/threshold level performs two functions (1) allows the operator to view a signal which exceeds a selected positive or negative level and (2) aids in the capture of transient waveforms of unknown polarity by triggering on the first waveform transition. Figure 2-7C shows the operation of bislope triggering.

To set the LEVEL control, first select TRIGGERING (COUPLING, SOURCE, POSITION and SLOPE). Then set the LEVEL/SENSITIVITY control fully counterclockwise and rotate it clockwise until the the desired trigger point (level) is attained.

To set the SENSITIVITY control, first select TRIGGERING (POSITION COUPLING, SOURCE and BISLOPE). Then set the SENSITIVITY control fully counterclockwise to MAX. If the input signal is of sufficient amplitude (see Specification in Section 1), the trigger circuit will stabilize the display. Rotating the SENSITIVITY control clockwise from its MAX sensitivity position, moves the + and − trigger threshold levels away from their maximum sensitivity levels. The + level becomes more positive and the − level becomes more negative, and the trigger circuit will require a larger input signal to operate. The trigger circuit will stabilize the display when the input crosses either the + or − threshold level.

The bislope feature is useful for detecting randomly occurring events and storing them for continuous viewing. Because SENSITIVITY is adjustable, it may be set to ignore low-level, but capture higher-level, transitions.

TRIGGERING SOURCE

The Triggering Source push buttons select the source of the trigger signal that is connected to the internal trigger circuits.

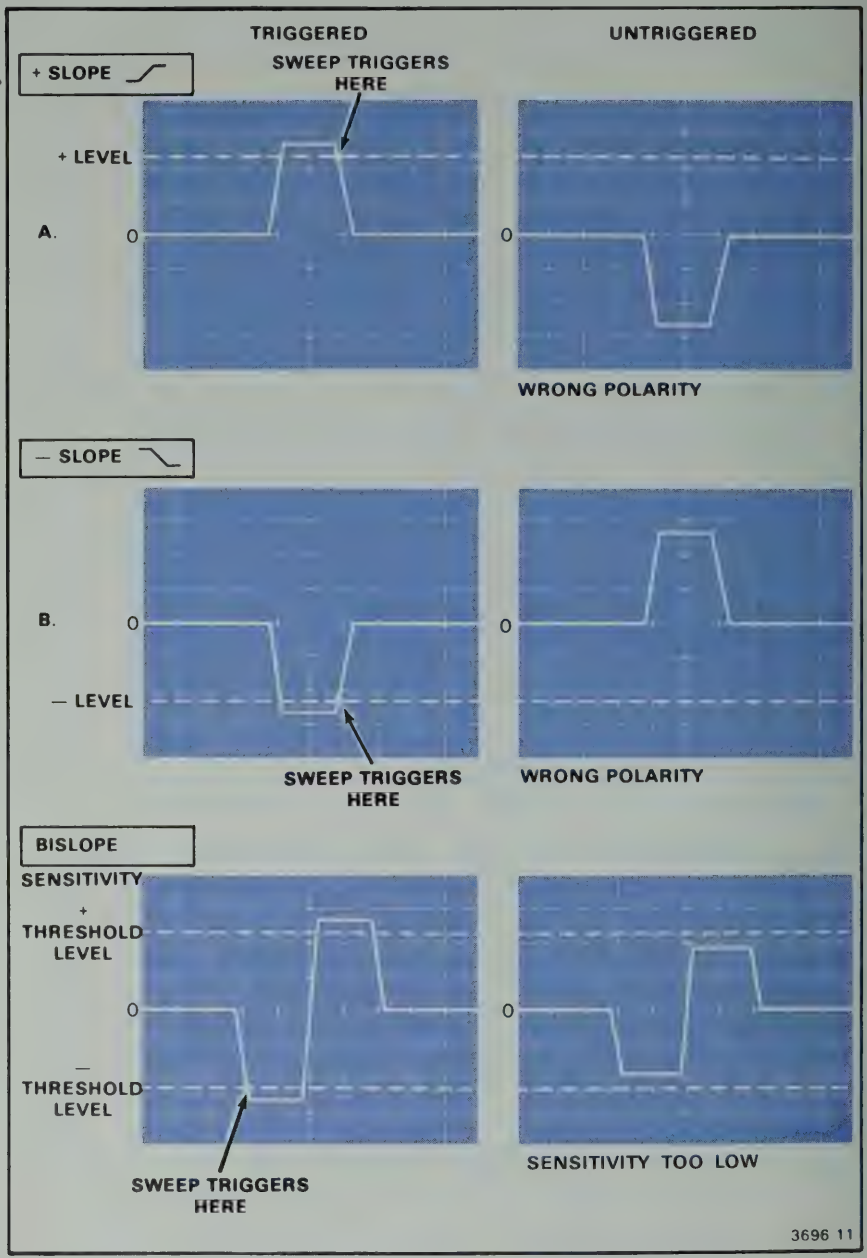
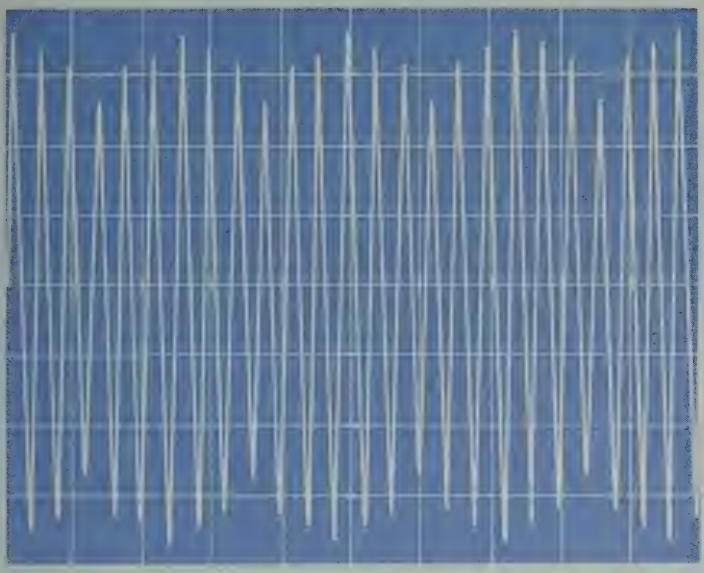
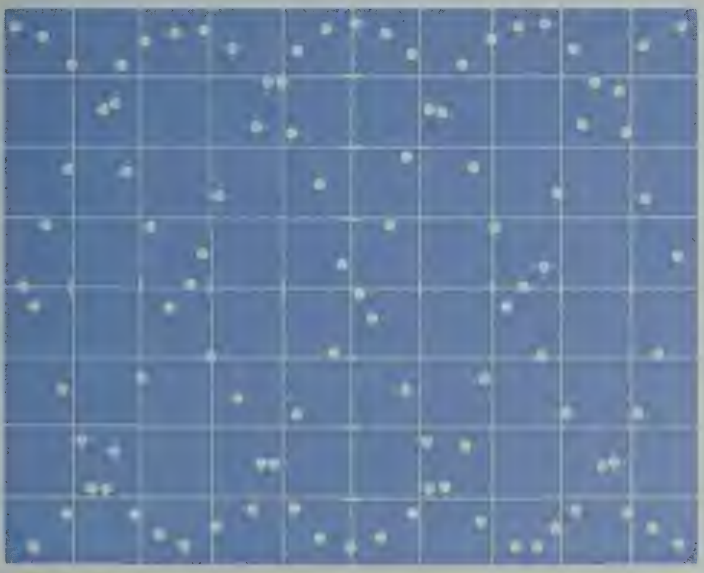


Figure 2-7. Operating characteristics of the triggering slope functions.



A. JOIN DOTS DISPLAY



B. DOT DISPLAY

3696-10

Figure 2-8. Perceptual aliasing illustrated.

CH 1, CH 2, Left Plug-In

Normally the triggering signal source will be the same as that selected at the ACQUISITION AND DISPLAY selector. (The CH 1 TRIGGERING SOURCE push-button provides a trigger signal obtained from the signal applied to the CH 1 input bnc connector.) However, some applications require special triggering which cannot be obtained internally. In such cases, the LINE or EXT positions of the SOURCE switches must be used.

LINE. The LINE position connects a sample of the power-line voltage from the mainframe to the trigger circuit. Line triggering is useful when the input signal is time-related (multiple or submultiple) to the line frequency. It is also useful for providing a stable display of a line-frequency component in a complex waveform.

EXTernal. The EXT position connects the signal from the EXT input connector to the trigger circuit.

An external trigger signal can be used to provide a triggered display when the internal signal is either too low in amplitude for correct triggering or contains signal components on which triggering is not desired. It is also useful when signal tracing in amplifiers, phase-shift networks, wave-shaping and logic circuits, etc.

The signal from a single point in the circuit can be connected to the EXT input connector through a probe or cable. The display is then triggered by the same signal at all times and allows amplitude, time relationship, or waveshape changes of signals at various points in the circuit to be examined without readjustment of the triggering controls.

JOIN DOTS [ACQUISITION AND DISPLAY]

The JOIN DOTS switch (button in) causes vectors (straight lines) to be drawn between consecutive data points of a dot display. See Figure 2-8A. Figure 2-8B shows the same display without vectors to illustrate the phenomenon called perceptual aliasing. Perceptual aliasing is a type of optical illusion that causes the eye to visually connect adjacent points in a dot display.

In addition to perceptual aliasing, dot displays can also show an envelope error even though vectors are drawn between the data points. This occurs when the sampled points do not fall on the peaks of the incoming signal. An increased sample rate will minimize this condition.

Each type of display construction (dots or vectors) yields a different useful storage bandwidth. Dot displays will need more samples-per-cycle on the crt screen to minimize perceptual aliasing and envelope errors. Vector displays need fewer samples-per-cycle since the vectors eliminate perceptual aliasing.

OPERATION AND INTERACTION OF SAVE AND SAVE REFERENCE

The following description details the operation and interaction of the SAVE and SAVE REF buttons with the cursor and scale factor readout fields, and the display and acquisition modes.

There are five acquisition and display modes—CH 1, CH 2, ADD, DUAL and XY. (The acquisition mode is DUAL when the display mode is XY.) These modes are selected by pushing the front-panel button with the same name. When the SAVE and SAVE REF buttons are out, the display and acquisition modes are the same as the mode selected by the front-panel buttons. Scale Factor fields on the crt screen will display the selected scale factor setting. After either the SAVE or SAVE REF button has been pushed, further changes in the front-panel ACQUISITION AND DISPLAY buttons will not change the acquisition mode. Refer to Table 2-1.

The CH 2, ADD, DUAL and XY modes are modified when the LEFT PLUG-IN is selected and is in dual-channel mode. The CH 2 portion of memory is split into two parts—one for LEFT CH 1 and one for LEFT CH 2. No changes are made in the acquisition or display modes (with regard to LEFT dual or single) if changes are made to the left plug-in after the SAVE or the SAVE REF buttons have been pushed.

When both SAVE and SAVE REF buttons are out, the acquisition and display modes are the same as the mode selected by the front-panel buttons. Cursor readout fields are not displayed. Scale factor fields display the present scale factor settings.

When the SAVE button is in and the SAVE REF button is out, changes in the scale factor settings will not change the displayed settings. The display mode is determined by the front-panel buttons according to Table 2-1. The acquisition mode does not change. Cursor fields will be displayed if CURSORS is not set to OFF.

When the SAVE button is out, and the SAVE REF button is in, changes in the scale factor settings will cause the associated scale factor readout field to be blanked. Cursor readout fields are also blanked. The display mode will be determined by the front-panel buttons according to Table 2-1. The acquisition mode will not change.

When the SAVE and SAVE REF buttons are both pressed in, changes in the scale factor settings will not change the displayed settings. The display mode is determined by the front-panel buttons according to Table 2-1. If the scale factor

TABLE 2-1
Interaction of SAVE and SAVE REF on ACQUISITION AND DISPLAY

The ACQUISITION AND DISPLAY Mode Switch setting selected after SAVE or SAVE REF is pressed (button in).		CH1	CH2	ADD	DUAL	XY
		(Resultant display format)				
The ACQUISITION AND DISPLAY mode switch setting when the signal was acquired and SAVEd	CH1	CH1	CH1	CH1	CH1	CH1
	CH2	CH2	CH2	CH2	CH2	CH2
	ADD	ADD	ADD	ADD	ADD	ADD
	DUAL	CH1*	CH2*	DUAL	DUAL	XY
	XY	CH1*	CH2*	DUAL	DUAL	XY

***The display in these modes is either the CH 1 or the CH 2 portion of the data in memory which is stored in dual-channel format.**

setting when SAVE was pushed is not the same as the setting when SAVE REF was pushed, the associated scale factor field is blanked (if CURSORS switch is set to OFF.) Each scale factor field will display the scale factor of the waveform (reference or new) on which C1 resides (if CURSORS switch is not set to OFF) and cursor values are calculated according to that scale factor.

MEASUREMENT CONSIDERATIONS

The maximum frequency that can be reconstructed accurately is limited by the number of traces to be displayed at any one time. Selection of the ACQUISITION AND DISPLAY mode, SAVE REF or LEFT PLUG-IN determines the number of traces and the number of data points available to display each trace.

If, for example, you pressed DUAL (single channel left plug-in), the number of data points available to each trace width would be 512 (1024 ÷ 2 = 512 data points). If SAVE REF was then pressed, the data points available to reconstruct each of the four traces would be reduced to 256 (1024 ÷ 4 = 256). See Table 2-2.

As the number of data points per trace is reduced, the maximum frequency that can be reconstructed accurately is also reduced. The POSSIBLE UNDERSAMPLING indicator will light when fewer than 8 samples (data points) are taken of each cycle of incoming signal. This light signals the operator that too few samples are being taken to accurately reconstruct the incoming signal.

TABLE 2-2
Measurement Frequency Limitations

Number of Traces	Data Points per Trace		Maximum Useful Input Frequency
	CH 1	CH 2	
1	1024	1024	100 kHz
2	512	512	50 kHz
3	512	256	25 kHz
4	256	256	25 kHz
6	256	128	12 kHz

ERASE CONDITIONS

An erase will occur if, during acquisition, any of the following occurs:

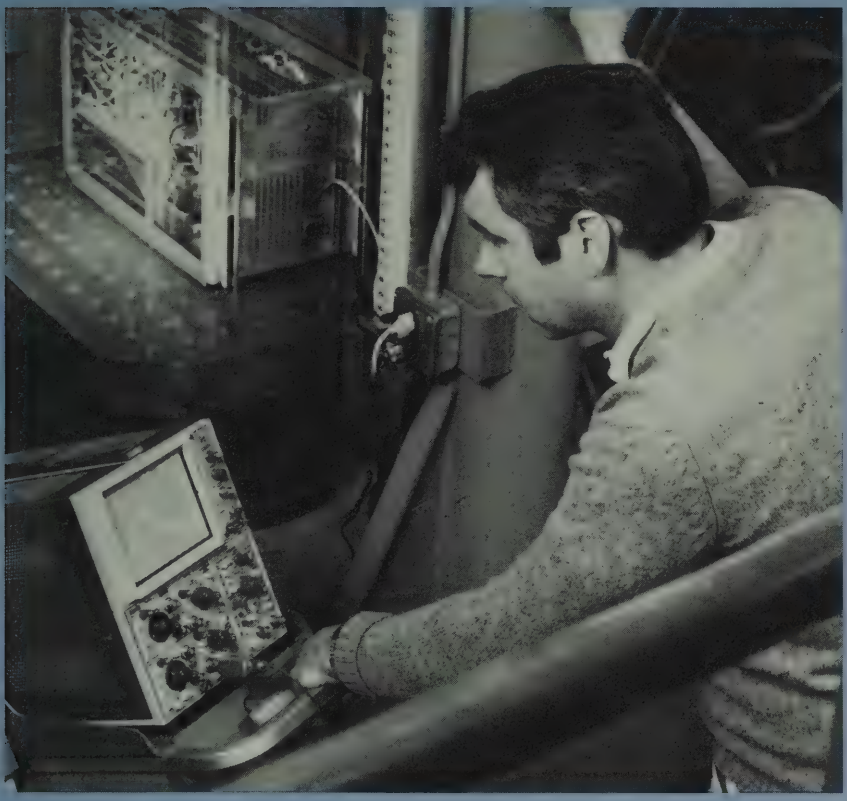
1. The SAVE or SAVE REF button is depressed then released.

2. The ACQUISITION AND DISPLAY mode, TRIGGERING POSITION, VOLTS/DIV, SECONDS/DIV or INVERT is switched.

3. The CH 1 or CH 2 VOLTS/DIV CAL control is switched out of its calibrated detent, or a probe is connected which changes the vertical scale factor readout.

At any time during the operation of the instrument (if SAVE button is not in) either pressing ERASE or interrupting the mainframe power will cause an erase.

3



The following information describes techniques for making waveform measurements featuring the cursor function of the 5D10 Waveform Digitizer. Basic measurements such as voltage, pulse width, and rise and fall time will be discussed first, followed by specific measurement techniques including stepper motor shaft settling time measurement, shock and vibration measurements and color plotting. These procedures provide enough detail to enable the operator to adapt them to other related waveform measurements. Contact your Tektronix Field Office or representative for assistance in making measurements that are not described in this manual.

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NOTE

Turn to Section 2, Operating Instructions and perform the Operators Checkout procedure before continuing with the following procedures. The Operators Checkout will familiarize the operator with the various functions of the 5D10.

APPLICATIONS

TIME-INTERVAL MEASUREMENTS

The following procedures provide methods to measure some of the more common time-related definable characteristics of a waveform such as voltage, period, frequency, rise time, fall time, and pulse width. The procedure for each of these measurements is essentially the same, except for the points between which the measurements are made. The time interval between any two selected points on a displayed waveform can be measured with basically the same technique.

VOLTAGE, FREQUENCY AND PERIOD MEASUREMENTS

Perform the following procedures to measure the voltage and period, and to determine the frequency of a displayed waveform:

Initial Setup Conditions

1. Install the 5D10 in the right vertical and horizontal compartments of the mainframe.

2. Connect the signal to be measured to either the CH 1 or CH 2 input connector.

3. Set the display switches to display the channel selected (check that the CAL control is fully clockwise).

4. Press JOIN DOTS (button in).

5. Set the TRIGGERING switches and LEVEL control for a stable display (see Operating Instructions for selecting proper triggering).

6. Set the vertical deflection factor and POSition control for a display that fills approximately two-thirds of the screen vertically, and is entirely within the screen area. Precise alignment with graticule lines is unnecessary.

Voltage Measurements

Perform the Initial Set Up Conditions, then proceed with the following instructions.

1. Press SAVE.

2. Switch CURSORS to C2-C1 position.

3. Move the cursors to the points between which the measurement is to be made.

4. Read the △ voltage directly from the screen.

Peak-to-peak voltage is determined by moving C2 and C1, watching for maximum △ voltage, and not particularly observing △ time.

Period and Frequency Measurements

1. Set the SECONDS/DIV switch to display at least one (1) complete cycle as shown in Figure 3-1.

2. Press SAVE.

3. Switch CURSORS to the C2-C1 position.

4. Using the individual C1 and C2 cursor motion switches, position the cursors one (1) cycle apart. (△ = 0.00V is displayed). See Figure 3-1.

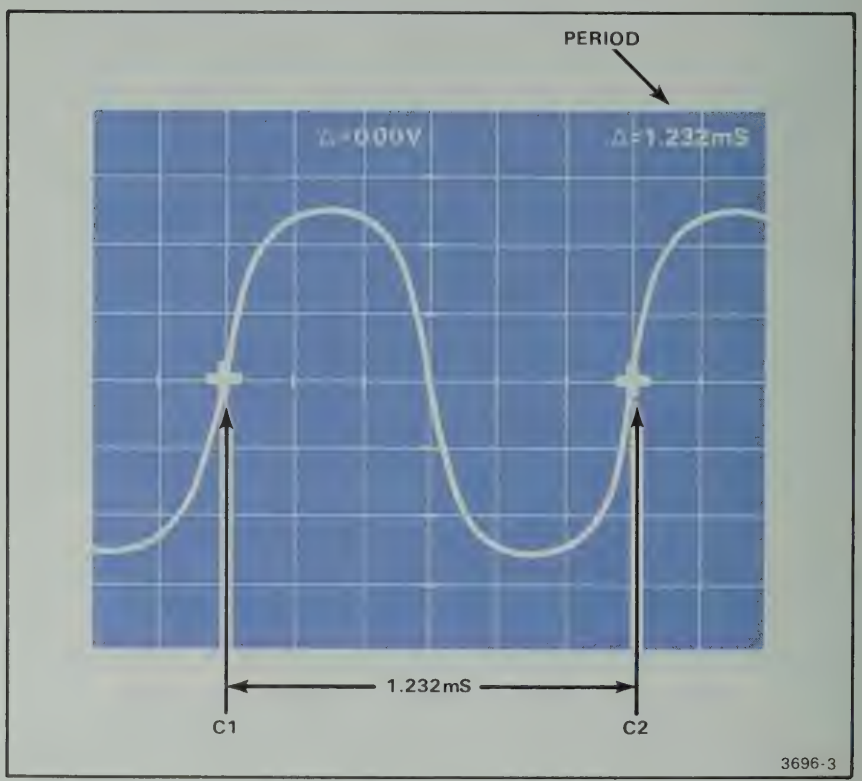


Figure 3-1. Measuring the period of a displayed waveform using CURSOR C1 as the reference.

NOTE

It is not always possible to read 0 V. Choose the point with the smallest △ magnitude or increase the sample rate to minimize the condition.

5. The period of one (1) cycle will be displayed on the crt readout. See Figure 3-1.

The frequency of the displayed waveform obtained in preceding steps may be determined by calculating the reciprocal of the period of one (1) cycle.

Example: Assume that the period of the displayed waveform is 1.232 milliseconds.

Using the formula: Frequency = 1/period

Substituting values:

Frequency = 1/1.232 milliseconds = 811 hertz

RISE-TIME MEASUREMENTS

Determine the rise time by measuring the time difference with the use of the cursors, between the point on the rising portion of the waveform that is 10% and the point that is 90% of the total display amplitude.

Perform the following procedure to measure the rise time of a displayed waveform:

NOTE

The particular numbers relating to time and voltage in the following procedure were used for explanation only.

1. Perform the Initial Set-Up Conditions.
2. Press SAVE, then switch CURSORS to C2-C1 position.
3. Position the cursors at the extremes of the waveform excursion (measure the p-p voltage). Refer to Figure 3-2A.
4. Note the amplitude of the displayed waveform from the readout.
5. Subtract 10% from the number obtained in steps 3 and 4.
6. Move cursor C2 along the waveform (toward C1) until the readout displays the number calculated in step 5. See Figure 3-2B.
7. Subtract 10% of the number obtained in steps 3 and 4 from the number now displayed in the readout.
8. Move cursor C1 until the number calculated in step 7 is displayed in the readout. See Figure 3-2C.
9. Read the rise time from the display readout.

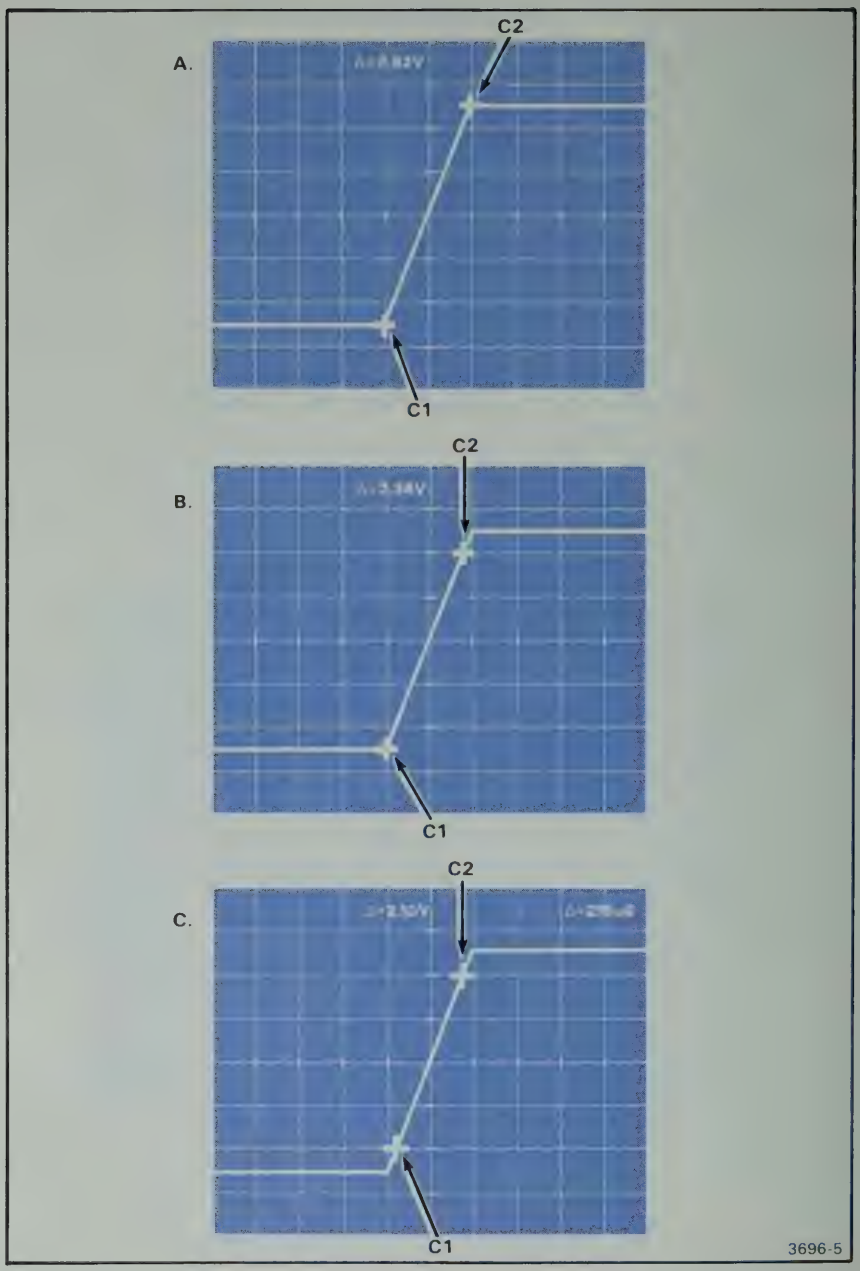


Figure 3-2. Measuring the risetime of a pulse.

FALL-TIME MEASUREMENTS

Perform the following procedure to measure the fall time of a displayed waveform.

Determine the fall time by measuring the horizontal distance, with the use of cursors, between the point on the falling portion of the waveform that is 10% and the point that is 90% of the total display amplitude.

1. Perform the Initial Set-Up Conditions.
2. Press SAVE, then switch CURSORS to C2-C1 position.
3. First, position the cursors (C1, C2) at the extremes of the waveform excursion (measure the p-p voltage). See Figure 3-3A.
4. Note the amplitude of the displayed waveform from the readout.
5. Subtract 10% from the number obtained in steps 3 and 4.
6. Move cursor C1 along the waveform (toward C2) until the readout displays the number (approximately) calculated in step 5 (see Fig. 3-3B).
7. Subtract 10% of the number obtained in steps 3 and 4 from the number now displayed in the readout.
8. Move cursor C2 until the new number (calculated in step 7) is displayed in the readout (see Fig. 3-3C).
9. Read the fall time from the display readout.

PULSE WIDTH MEASUREMENTS

Use the following procedure to measure the width of a pulse:

NOTE

The particular numbers relating to time and voltage in the following text and illustration were used for explanation only.

1. Perform the Initial Set-Up Conditions.
2. Press SAVE, then switch CURSORS to the C2-C1 position.
3. Measure the p-p voltage. Position the cursors at the extremes of the waveform excursion. Refer to Figure 3-4A. Note the amplitude of the displayed waveform from the readout (480 mV).
4. Move cursor C1 toward C2 one-half the distance of the p-p voltage found in step 3. Figure 3-4B shows 240 mV.

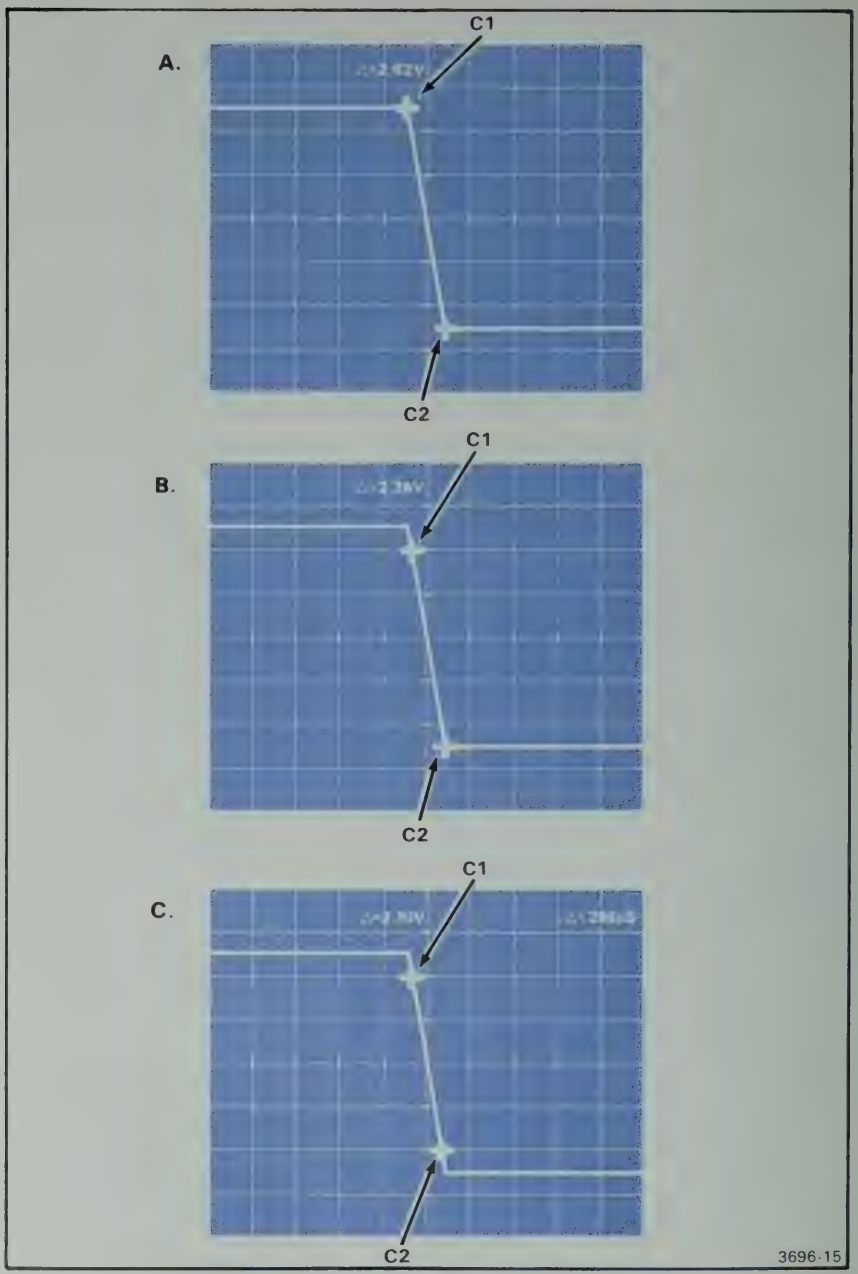


Figure 3-3. Measuring the falltime of a pulse.

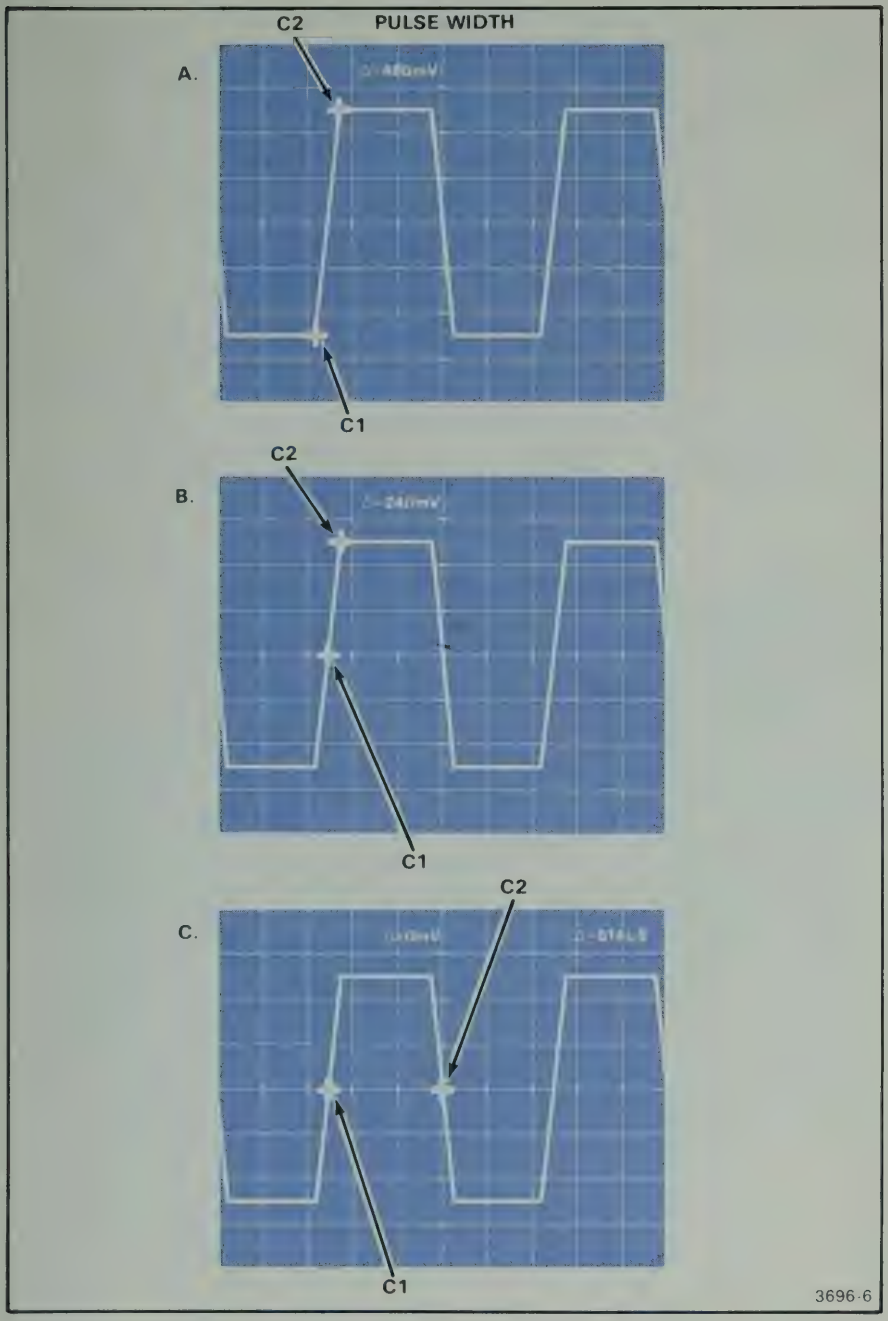


Figure 3-4. Measuring the pulse width.

NOTE

Position the cursor to the calculated data point or the data point nearest the calculated voltage.

5. Move cursor C2 until a △ reading of 0 mV (or as close as possible) is displayed in the readout. Read the pulse width from the display readout (△ = 514 μs). See Figure 3-4C.

TRIGGERING POSITION

Since the crt display is constructed of digitized points stored in memory, the events prior to the trigger point may be displayed.

The Triggering Position function allows observation of either 5 or approximately 9 divisions before or after the trigger point.

In applications where it is desired to view the response to a stimulus, it may be advantageous to view the time-window where the stimulus occurred. For example,

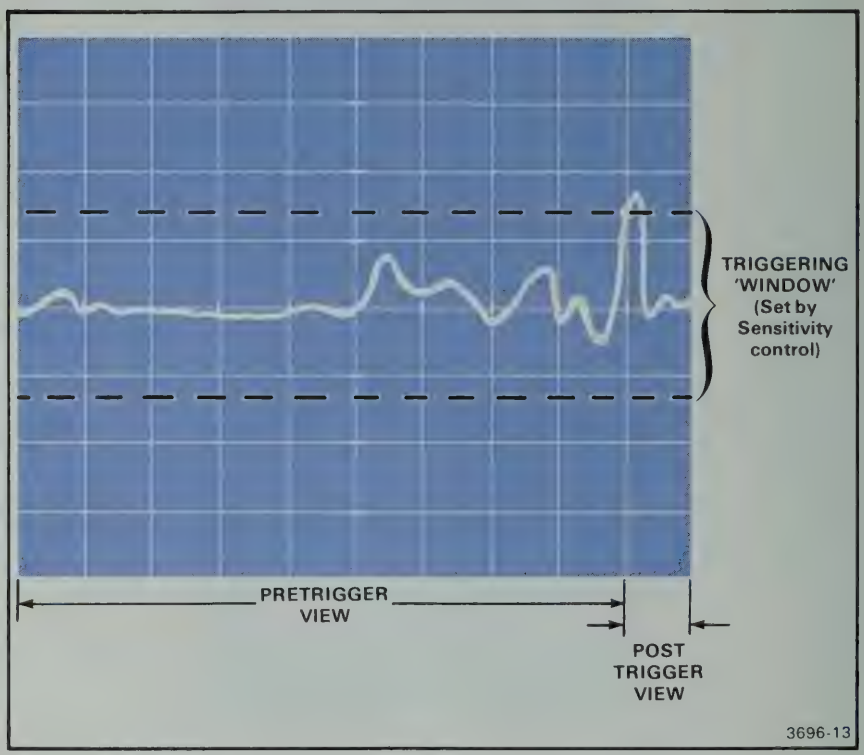


Figure 3-5. Waveform showing TRIGGERING set to BISLOPE and PRETRIG.

if the sweep rate were set to 1 ms, events occurring at least 5 ms (CTR/TRIG) or approximately 9 ms (PRE/TRIG) prior to the trigger point could be observed. Figure 3-5 shows an event viewed with the TRIGGER selector in the PRE TRIGger viewing position.

One application for PRE TRIGger viewing is to view small transitions on a power-supply output prior to the loss of that output. Figure 3-6 illustrates how the PRE TRIGger control can be used to locate and study possible fault indications in the output of the supply under test by triggering on the supply shutdown transition.

If the TRIGGERING were set to CTR TRIGger the fault would not have been captured. (CTR TRIGger will display approximately 5 crt divisions (512 data points) prior to the triggering event.)

Another application of the PRE or CTR TRIGGERING function is to view the stimulus in a vibration test to determine the extent or content of deformation prior to the breakage of the part under test.

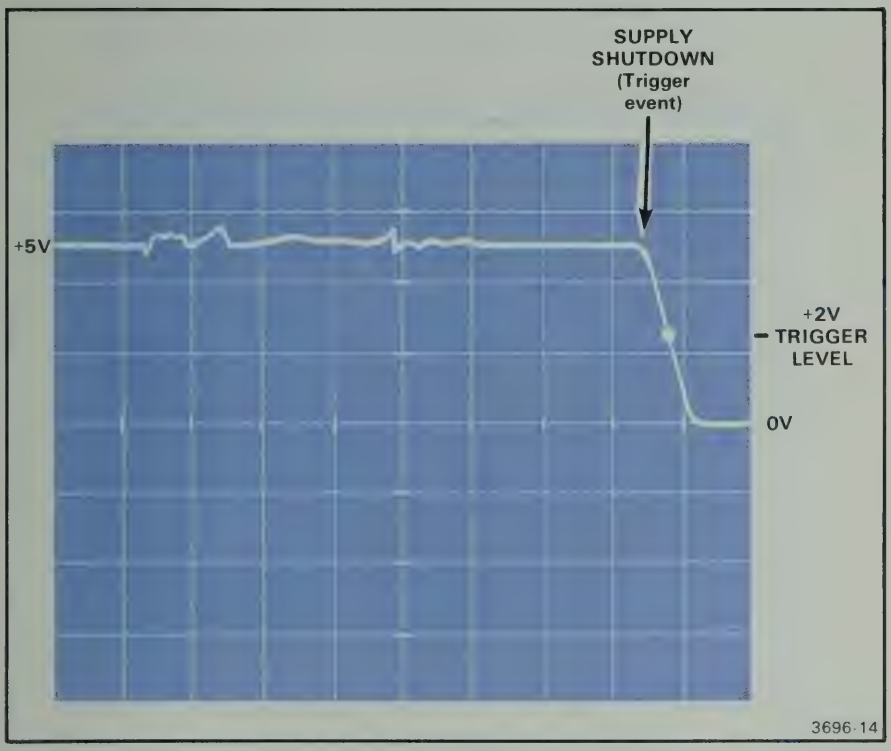


Figure 3-6. PRETRIGGER view of power supply shutdown conditions.

WAVEFORM COMPARISON

Repeated comparisons (amplitude, timing, pulse-shape analysis) of unknown signals with a reference signal is easily and accurately accomplished using the SAVE and SAVE REFerence functions of the 5D10.

Use the following procedure to make waveform comparisons:

1. Acquire the known reference signal using the VOLTS/DIV and SECONDS/DIV switch settings that will display the reference signal with the desired vertical deflection and sweep rate.

2. Press SAVE REF; the signal will be stored in memory.

3. Acquire the waveform that is to be compared with the reference waveform.

4. Use the POSition control to overlay the comparison waveform on the reference waveform (see Fig. 3-7). Press SAVE. Press TRACE SEP to move reference waveform to identify.

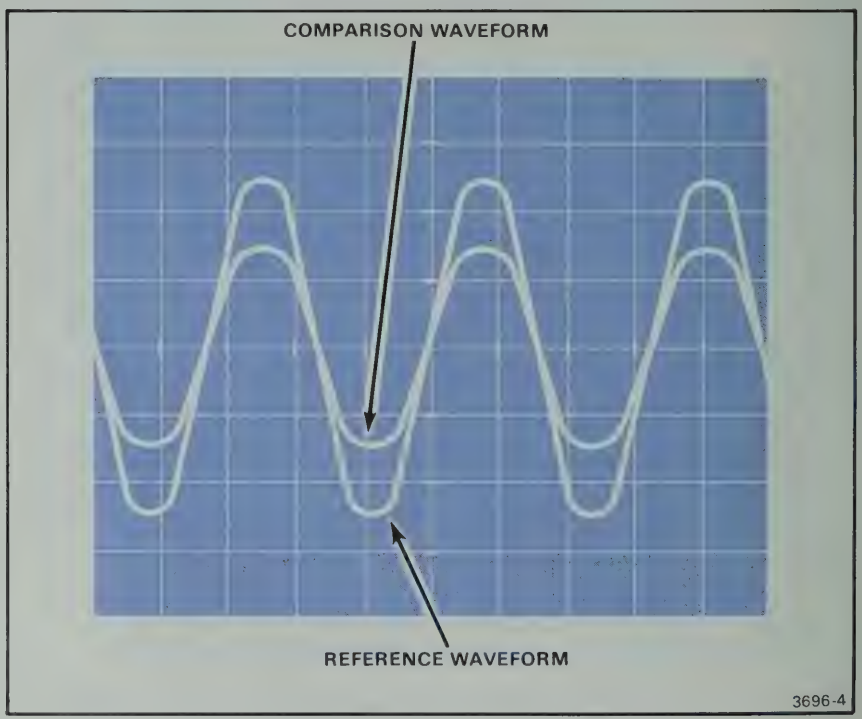


Figure 3-7. Waveform comparison using SAVE REF.

NOTE

Either Channel 1, 2, or Channel 2 Left Plug-In, may be used for acquiring comparison or reference waveforms.

PHASE MEASUREMENTS USING XY MODE

Phase comparison between two signals of the same frequency can be made using Cursors and the XY functions of the 5D10.

Perform the power-up requirements then proceed with the following instructions:

1. Connect the reference signal to the CH 1 input connector and comparison signal to the CH 2 input connector.

2. Set the VOLTS/DIV switches and POSition controls to obtain the desired vertical deflection and positioning.

NOTE

Displays that individually fill the center 2/3 of the screen area and approximately equal in amplitude will render a very usable waveform when X:CH1/Y:CH2 is pressed.

3. Set the Triggering controls to obtain a stable display for each channel. Set the SECONDS/DIV switch to a rate which displays about 2 cycles of the waveform.

4. Press X:CH1/Y:CH2. Press SAVE, then switch CURSORS to C2-C1 position.

5. Refer to Figure 3-8 to calculate the phase difference of the two signals.

NOTE

CURSORS motion switch in C1 − position
—if cursor moves counterclockwise, CH 1 leads CH 2
—if cursor moves clockwise, CH 2 leads CH 1

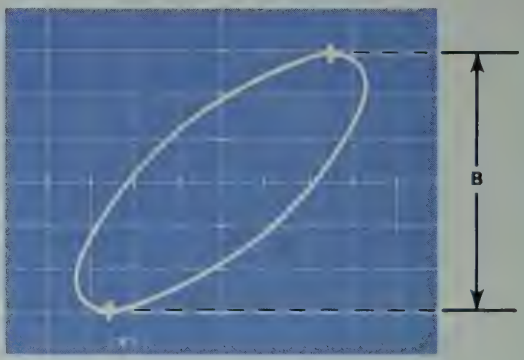
SETTLING TIME MEASUREMENT

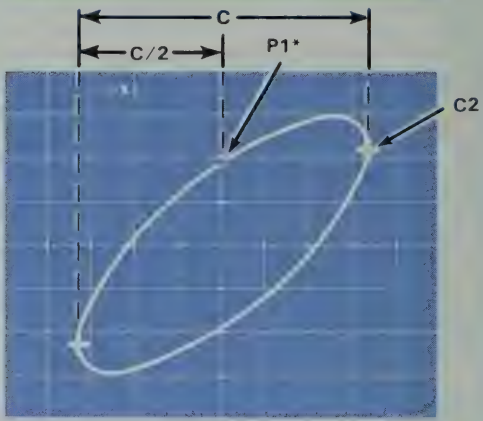
This application deals specifically with measuring the settling time of the shaft position of stepper motors.

The speed and accuracy at which a stepper motor settles to its absolute position must be known in designing computer controlled mechanical devices such as automated laser trimmers, high quality recorders and printers, and robotic arms.

Depending on the application, the position accuracy required may dictate the speed or response time of the entire system.

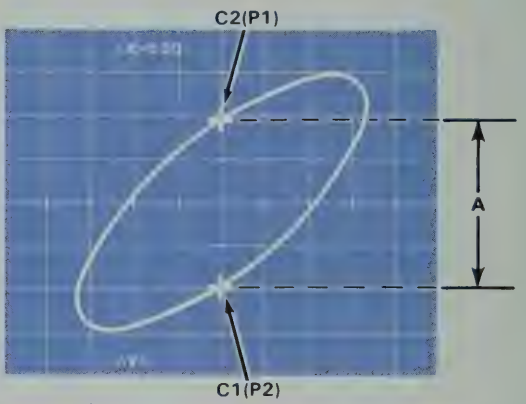
1. Find B: Move cursors to max △Y (B).





2. Find P1: Find max △X (C), divide by 2, then move cursor C2 until that number (C/2) appears in the readout (to point P1).

*The open circle is not part of the trace



3. Find P2: Move C1 so △X=0V (to point P2). Read A (△Y).

4. Substitute in the formula $\Theta = \arcsin \frac{A}{B}$, the values obtained in the above steps.

3696-16

Figure 3-8. Phase measurements using XY mode.

NOTE

The Settling Time Measurement procedure requires the use of the Left Plug-In mode. Refer to Table 1-1 Mainframe Compatibility and Table 1-3 Plug-In Compatibility in Section 1, General Information to determine whether modification is necessary.

Refer installation of modifications to qualified service personnel.

Perform the following procedure to determine the settling time. (Refer to time and voltage measurement techniques given earlier.)

1. Provide a signal from the stepper shaft encoder to CH 1 of the 5D10 and to the + input of the 5A13N Differential Comparator. See Figure 3-9 for

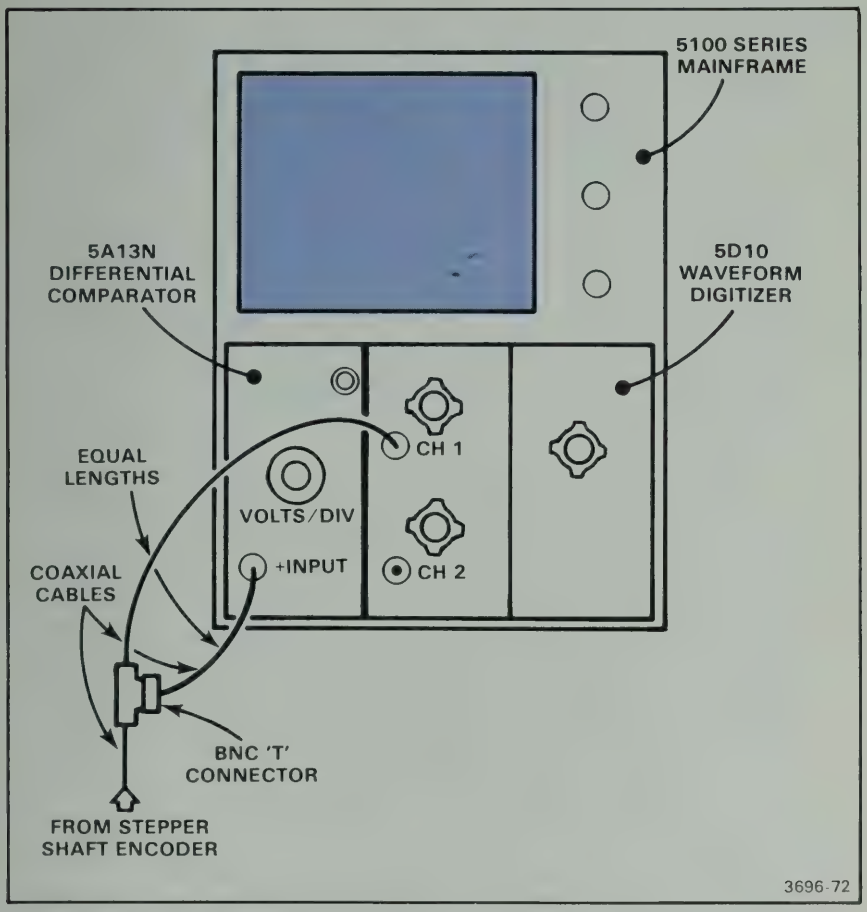


Figure 3-9. Interconnections for settling time measurement of stepper motor shaft.

interconnections and the instruction manuals of the associated equipment (encoder, 5A13N Differential Comparator) for specific operating information.

2. Press CH 1 (ACQUISITION AND DISPLAY) and POST TRIG.

3. Obtain a triggered display similar to that shown in Figure 3-10A.

4. Switch CH 2 VOLTS/DIV to 20 V. Center the display.

5. Switch CH 2 VOLTS/DIV to the LEFT PLUG-IN position then press CH 2 (ACQUISITION AND DISPLAY).

NOTE

Use the position controls on the plug-in installed in the left vertical compartment when the CH 2 VOLTS/DIV switch is in LEFT PLUG-IN mode.

6. Press Display On (5A13N). Rotate the Volts/Div switch until the desired sensitivity is reached.

NOTE

The desired sensitivity for the 5A13N is that which allows an accurate measurement of the specified tolerance requirement. i.e., ± 20 mV of a 3 V dc level.

Adjust COMPARISON VOLTAGE (5A13N) to maintain the settled portion of the waveform on screen. See Figure 3-10B.

7. Press DUAL (5D10). Position CH 1 and CH 2 LEFT PLUG-IN (5A13N) waveforms as shown in Figure 3-10C.

8. Press SAVE, then switch CURSORS to C2-C1 position.

9. Position both cursors to the portion of the waveform that represents the settled shaft.

10. Move cursor C1 back (left) along the waveform until the tolerance is displayed (△=-0.20D).

11. Move C2 left to the same data point as C1 (△=0.00ms); then move C1 left to the 50% point on the rising edge of the reference waveform.

NOTE

The settling time is defined as the time from the 50% point of the rising edge to the point where the signal is within a specified level.

12. Read the settling time from the display readout.

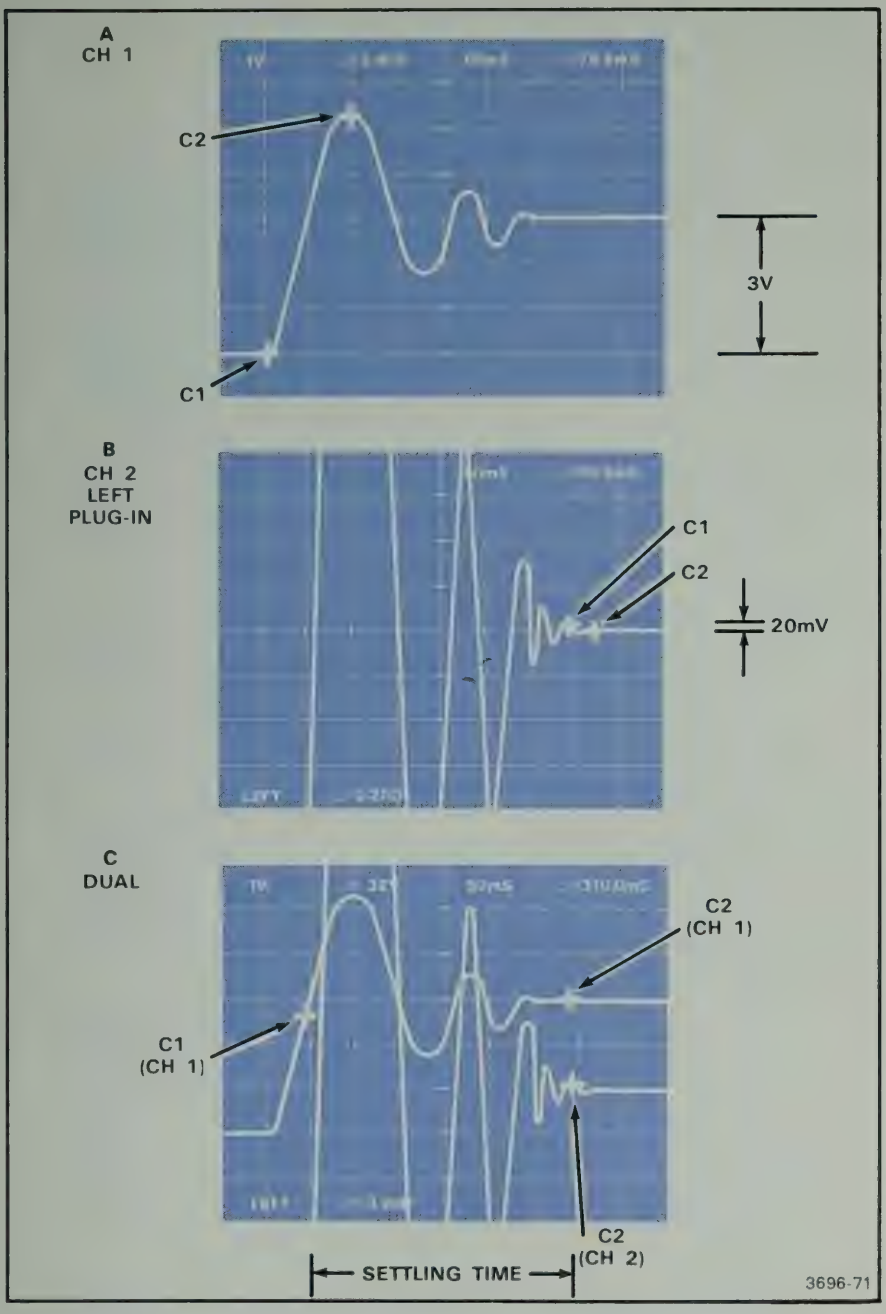


Figure 3-10. Typical waveforms generated during settling time measurement procedure.

A permanent record of the acquired data can be made using an XY recorder properly connected to the front-panel (5D10) SAVED DISPLAY OUTPUT jacks. Refer to Permanent Waveform Records Using an X-Y Recorder.

SHOCK AND VIBRATION MEASUREMENTS

The following procedure is used to display then measure the electrical impulse generated by an accelerometer when a moving object to which the accelerometer is affixed impacts (shock) or changes direction (vibration).

The impulse generated by the accelerometer is processed by a charge amplifier then fed to the input of the 5D10 Waveform Digitizer. The 5D10 acquires then displays a waveform on the crt. Cursors are used to measure the time and amplitude of the resultant waveform.

It may be desirable to measure the amplitude or duration of an inpact for purposes of designing or testing chassis parts, mounting hardware, packaging methods and materials, electrical component breakdown tolerance, meeting predetermined environmental specifications, etc.

NOTE

The Shock and Vibration Measurement procedure may require the use of the Left Plug-In mode (if more than 2 signals are acquired simultaneously).

Refer to Table 1-1 Mainframe Compatibility and Table 1-3 Plug-In Compatibility in Section 1, General Information to determine whether modification is necessary.

Refer installation of modifications to qualified service personnel.

Perform the setup requirements shown in Figure 3-11 then proceed with the following instructions.

NOTE

Refer to the Instruction Manuals for the charge amplifier and accelerometer for operating information.

1. Press CH 2 (ACQUISITION AND DISPLAY), CH 2 (TRIGGERING, CTR TRIG and BISLOPE).

2. Rotate SENSITIVITY to MAX, the SECONDS/DIV to 10m and the STORAGE VIEWTIME to INFinity.

3. Initiate a signal from the accelerometer. The signal should be similar to that shown in Figure 3-11. Adjust the VOLTS/DIV (5D10) and the charge amplifier to the desired sensitivity.

NOTE

Press PUSH:ERASE to clear the screen, then reapply the signal. Repeat until the desired results are achieved.

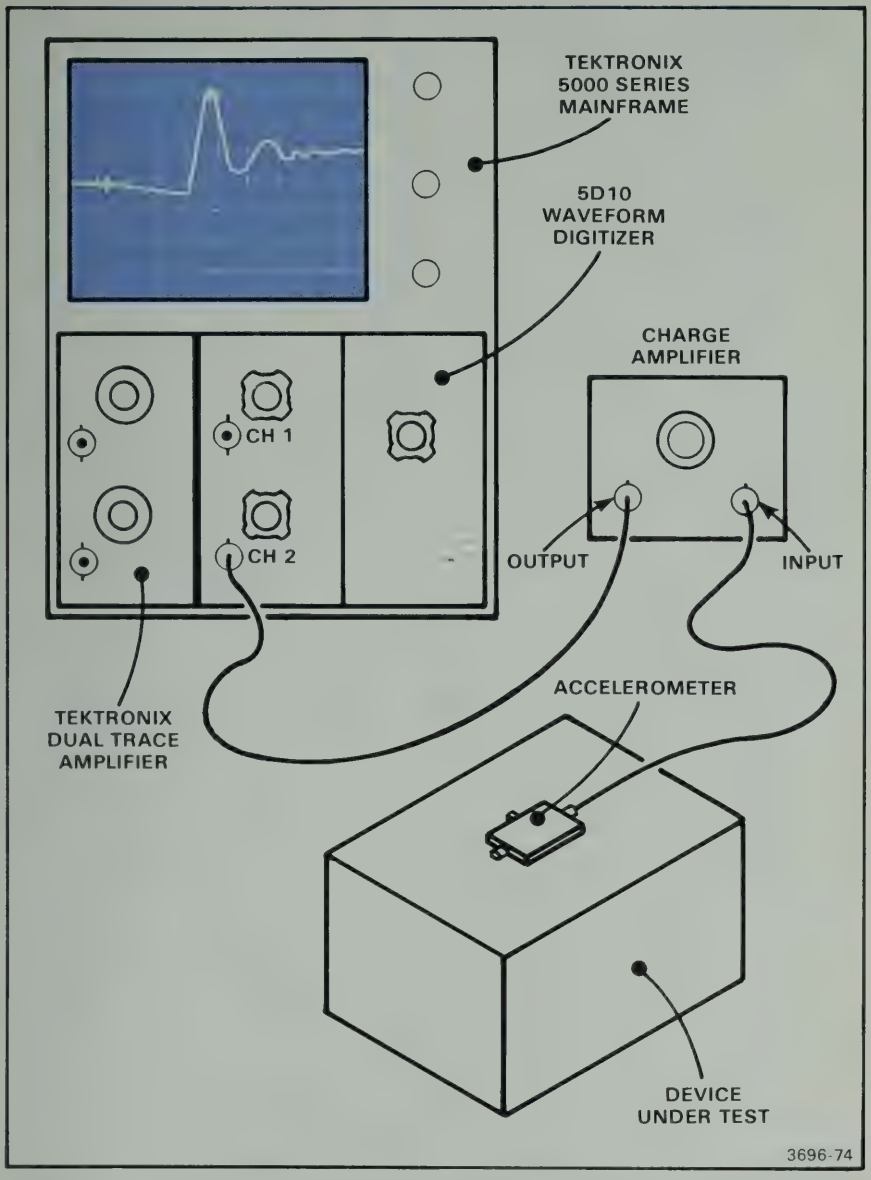


Figure 3-11. Typical waveform and interconnections for shock and vibration measurements using an accelerometer.

4. Switch CURSORS to C2-C1 position. Using the individual cursor motion switches, position each cursor to measure the desired parameter. (Refer to time and voltage measurement techniques given earlier.)

The accelerometer is capable of outputting 3 separate signals. Simultaneous sampling and display requires a multichannel charge amplifier or 3 individual charge amplifiers and a dual channel plug-in (5A26).

Proceed with the following instructions for 3 channel acquisition:

1. Press CH 2 (ACQUISITION AND DISPLAY) and FREERUN. Center the display.

2. Set the CH 2 VOLTS/DIV switch to LEFT PLUG-IN. Using the left plug-in controls, center the Ch 1 trace and move the Ch 2 trace to approximately 2 divisions from the bottom of the screen.

3. Switch to CH 1 (ACQUISITION AND DISPLAY). Move the trace to the center of the upper half of the graticule area.

4. Press DUAL, BISLOPE and select LEFT PLUG-IN of the 5D10.

5. Rotate SENSITIVITY to MAX, the SECONDS/DIV to 10m and the STORAGE VIEWTIME to INFinity.

NOTE

The SECONDS/DIV switch setting depends on the results desired and the acquired signals.

6. Initiate a signal from the accelerometer. The signals should be similar to that shown in Figure 3-11 (3 signals). Adjust the CH 2 VOLTS/DIV and the CH 1 and CH 2 VOLTS/DIV of the left plug-in to the desired sensitivity.

NOTE

Press PUSH:ERASE to clear the screen, then reapply the signal. Repeat until the desired results are achieved.

7. Switch CURSORS to C2-C1 position. Using the individual cursor motion switches, position each cursor to measure the desired parameter. (Refer to time and voltage measurement techniques given earlier.)

NOTE

The cursor readout is in divisions for the LEFT PLUG-IN signals.

A permanent record of the acquired data can be made using an XY Recorder properly connected to the front-panel (5D10) SAVED DISPLAY OUTPUT jacks. Refer to Permanent Waveform Records Using An X-Y Recorder.

PERMANENT WAVEFORM RECORDS USING AN X-Y RECORDER

Permanent waveform records can be made with an X-Y recorder properly connected to the 5D10 front-panel SAVED DISPLAY OUTPUT connectors (Y, X, PENLIFT).

Refer to Recorder System specifications in the General Information section for X-Y recorder requirements.

Normal Plot

Perform the setup shown in Figure 3-12, then proceed with the following instructions:

NOTE

Determine the requirements of the pen lift mechanism. Refer to the recorder instruction manual or run a practice plot.

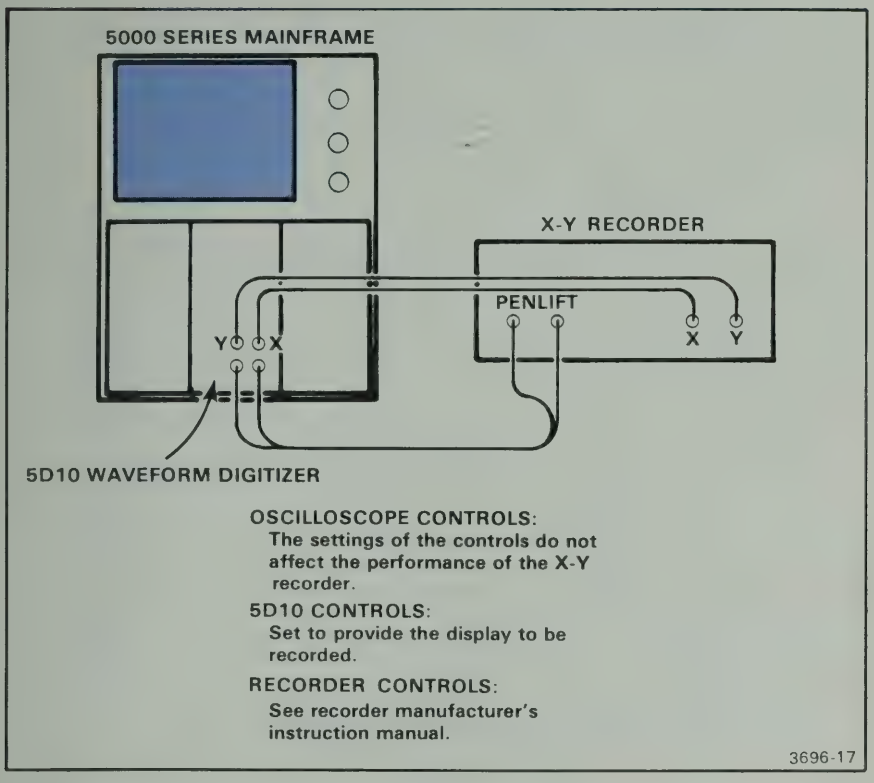


Figure 3-12. Interconnections for using an XY Recorder with the 5D10.

1. Position the waveform to the center of the graticule area.

NOTE

Normally, the center of the graticule corresponds to the center of the working area of the X-Y recorder. Adjustment of the X-Y recorder center point will move the reproduced graticule anywhere within the recorder work area.

2. Press SAVE.

3. Position the recorder pen to the point that you desire as the center of the copied waveform(s).

4. Set the sensitivity of the recorder using Table 3-1 as a guide.

TABLE 3-1
Recorder Sensitivity Selection

Recorder Sensitivity (V/inch)	Plot Size (inches)
0.5	3.2 × 4.0
0.2	8.0 × 10.0

5. Press SAVED DISPLAY OUTPUT PLOT.

The recorder will continue to copy until the SAVED DISPLAY OUTPUT PLOT button is pressed or the plot is completed. When the plot is completed the crt will unblank.

Three Color Plot

A color plot to enhance the readability of dual channel displays can be produced if the recorder is fitted with a replaceable (rather than refillable) pen.

NOTE

Color plots are especially useful when making waveform comparisons.

See Figure 3-13 for pen color selection.

After the plot is completed for both channels, the graticule, the time scale factor readout, and the time cursor field will be represented by the combination of the 2 selected channel colors, i.e., CH 1 – Blue, CH 2 – Red, graticule, time scale factor and cursor readout – violet.

To produce a color plot proceed with the following instructions:

NOTE

Refer to the Normal Plot procedure for preliminary setup requirements.

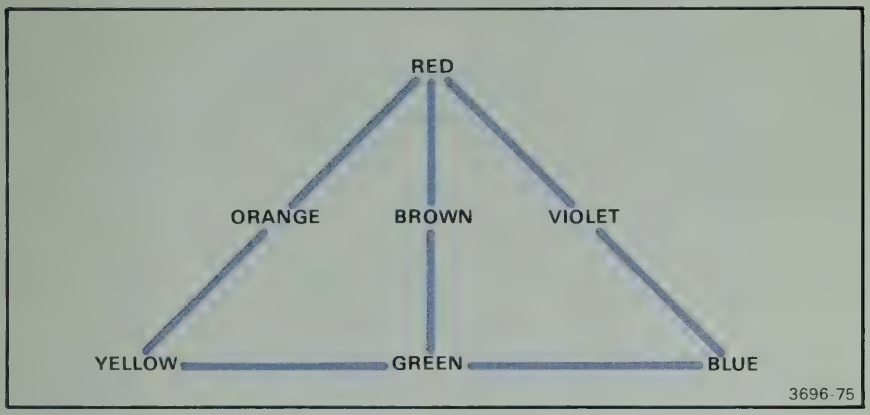


Figure 3-13. Pen color selector guide.

1. Connect signals to CH 1 and CH 2 input bnc connectors. Press DUAL (ACQUISITION AND DISPLAY).

2. Position the waveforms (using individual POSition controls) to the desired location within the graticule area.

3. Press SAVE.

4. Press CH 1, then press PLOT.

5. After the channel 1 plot is completed, the screen will unblank. Change pen color.

NOTE

Do not change position of cursors. The time cursor readout is shared between displays.

6. Press CH 2, then press PLOT. When the plot is complete the screen will unblank. Press DUAL.

Dot Plot

A plot consisting of the individual sampled points of a waveform (including the readout fields) can be made by releasing the JOIN DOTS pushbutton (button out). This mode is useful primarily for XY displays.

Follow the procedure for Three Color Plots except: start with JOIN DOTS (button in) for CH 1 data then release JOIN DOTS for dot plot of CH 2 data.

DIFFERENTIAL MEASUREMENTS

Interference resulting from ground-loop currents between the 5D10 and the device under test can be reduced significantly by connecting the signals in a differential fashion.

Only the voltage difference between two signals is amplified and displayed in differential measurements, while the common mode signals (common in amplitude, frequency and phase) are cancelled.

The ability of the 5D10 to reject common-mode signals is indicated by the common-mode rejection ratio (CMRR). See Specifications in section 1.

The following procedure, coupled with Figure 3-14, shows the elimination of a line-frequency component of a waveform.

1. Perform the normal power-up requirements given earlier.

2. To CH 1 input, connect the signal containing both the desired and undesired information. (Figure 3-14A).

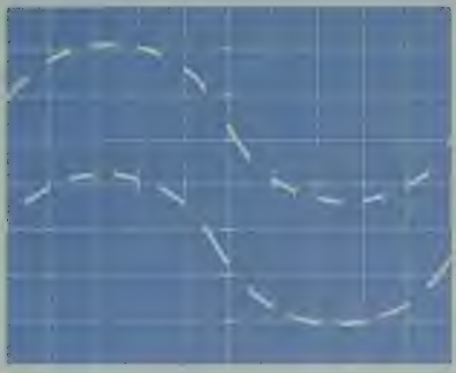
3. To CH 2 input, connect a signal similar to the undesired information on channel 1. (Figure 3-14B).

4. Press CH 2 INVERT.

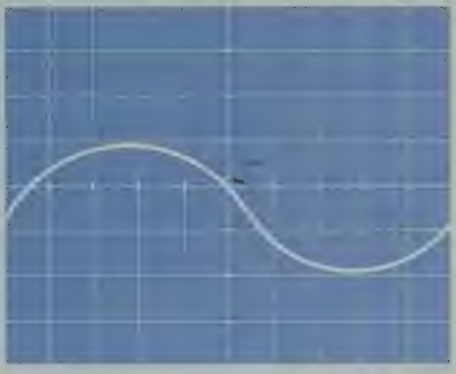
5. Press ADD (ACQUISITION AND DISPLAY). Figure 3-14C shows the resultant crt display using common mode rejection.

The 5D10 was not designed for high common mode rejection. In instances when this feature is required, install a differential amplifier such as the 5A22 or 5A26 (with cmrr of 100,000 to 1) in the left vertical compartment of the mainframe. Using the left plug-in mode of the 5D10 the features that each plug-in unit provides can be fully realized.

(A) CHANNEL 1 SIGNAL



(B) CHANNEL 2 SIGNAL



(C) RESULTANT DISPLAY

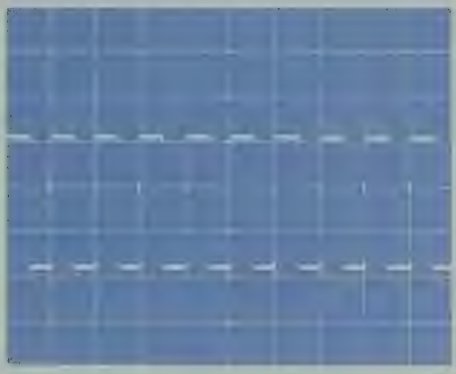


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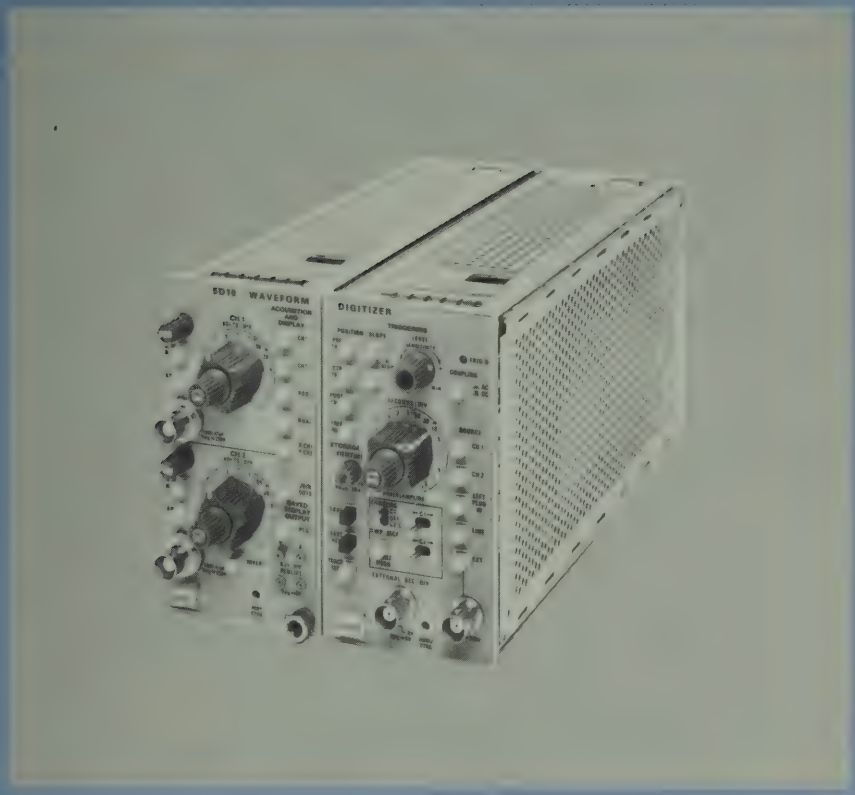
Figure 3-14. Differential measurements (CMRR).

SECTION FOUR
INSTRUMENT OPTIONS

4



Your 5D10 Waveform Digitizer may include one or more options. This section includes a brief description of each option. For further information about available options, refer to the Tektronix Products Catalog or contact a Tektronix Field Office.

SECTION 4

INSTRUMENT OPTIONS

No options were available for the 5D10 at the time of this printing.

Information about any future options can be found in the Change Information section at the back of this manual.

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